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THE UNIVERSITY OF ALBERTA

TOWARDS AN UNDERSTANDING OF PRESERVICE TEACHERS' PERCEPTIONS OF AN ELEMENTARY MATHEMATICS CURRICULUM AND INSTRUCTION COURSE

BY

CAROL MARIE CUNNINGHAM HAUK

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
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OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF ELEMENTARY EDUCATION

EDMONTON, ALBERTA
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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled TOWARDS AN UNDERSTANDING OF PRESERVICE TEACHERS' PERCEPTIONS OF AN ELEMENTARY MATHEMATICS CURRICULUM AND INSTRUCTION COURSE submitted by CAROL MARIE CUNNINGHAM HAUK in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY.

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Supervisor

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Date: May 27, 1987

DEDICATION

To my mother, Lorrain, and to the memory of my father, Gordon.

ABSTRACT

The purpose of the study was to describe how preservice teachers experienced an elementary mathematics curriculum and instruction course. Data collected from five main participants as well as from all 180 students enrolled in the course gave rise to descriptive themes.

Getting Through the Course addressed the needs and expectations which are associated with being a student. Most students began the term eager to learn how to teach mathematics, but as time passed, pressures of the compressed term, class size, the assignment and tests soon began to cause concern. The major source of stress was evaluation procedures.

Feeling Prepared to Teach represented an important goal, though what was perceived as necessary to gain confidence differed among students. Some felt that they needed to learn more mathematics and improve their own skills, while others believed they had an adequate understanding of the content but wanted to know how to teach it. Students who had experience tutoring, giving private lessons or helping their own children learn often felt they already knew how to teach, while others felt like beginners.

Looking for Models described how the students looked both to former teachers and the instructors of this course when forming their own self-images as future teachers. They looked for models for lesson presentation, interaction with children and colleagues, and methods of

managing their classrooms. On the basis of their perceptions, they aspired to emulate those qualities and behaviors which they admired and eschew those traits and practices which they found objectionable.

Learning and Control were powerful and consistent themes in this study. Beliefs about control were often implicit, and even when identified were difficult to overcome. From a holistic learning perspective, the students learned that learning takes time, involves risk, can occur collaboratively yet be unique, requires motivation and readiness, and that understanding one's own learning has implications for understanding how children learn.

As a descriptive case study, understanding was the major goal. Specific recommendations were not made, but awareness of the themes and what gave rise to them could enhance sensitivity for recognizing them in other situations where specific circumstances may vary.

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CHAPTER I

INTRODUCTION

A typical day in the fall term for Bob began at 5:00 a.m. when he rose to deliver the morning newspaper. He then returned home to help his wife, whom he said worked "more than full time" as a nurse, to get their four children up and off to school. Next he headed for the university to begin a full day of classes, himself. Bob was in the midst of a career change. His past experience included nine years of police work, followed by independent employment in business and sales. The unstable economy led him back to university where he previously had obtained a B.A. in history, and, at the time of the study, he was enrolled in an after-degree program in education. He had chosen to become a teacher because, in his words: "I enjoyed working with my own children and I knew I could teach. I was fairly good at sales, and selling and teaching have a lot of points in common."

Helen, a mother of three school-age children, had wanted to be a teacher ever since she was little. She married when she was very young, and then moved to Alberta from Ontario where she was born and educated. Though she "cut" her education for a while to stay at home with her young children, she acknowledged the desire to teach school had "always been brewing." She found it quite difficult to return to studying, but had been inspired by her own children's teachers and the encouragement of her husband. Helen was very fond of children and admitted: "This is my way of always having them around, especially the little ones."

Lorna grew up in Northern Alberta. She began university at a different institution, and had hoped to transfer to the French education faculty, but decided that her fluency in the French language was insufficient. While her parents had spoken French to her as a child, she usually responded in English, and did not consider herself to be fully bilingual. Having completed only minimal mathematics requirements in high school, Lorna had since upgraded in this area. As she had an understanding instructor and a successful experience, her confidence in mathematics increased significantly, but she still had some anxieties. Registering at the last minute and adjusting to a new campus made the term hectic for Lorna, but she adjusted well and felt positive about becoming a teacher.

Raised in a nearby county, Dianne moved to the city prior to attending high school. She had positive feelings about her own early education and was very excited about the prospect of teaching, hopefully at the upper elementary level. Dianne studied the violin intensively for ten years, something which she, regrettably, let slip when she had begun the B.Ed. program at the university two years earlier. She had some experience teaching violin privately, and felt that music would be a difficult subject to teach in school. She contended that she was willing to teach "anywhere in Canada" for a year or so after graduation, and then hoped to travel and teach overseas. Dianne lived at home and had a younger sister and brother.

Jennifer, in the third year of the B.Ed. program, remarked that she "wouldn't rather be anywhere else right now!" Following high school, she went to Lake Louise where she spent a year as a ski mechanic and two summers at a back country hiking lodge. She really did not consider becoming a teacher until grade 11, but was quite sure that she had made the right choice. Raised in the city, Jennifer lived at home with her family. She was very fond of her nine-year-old sister, and took an active interest in her sister's mathematics learning.

These profiles suggest little support for the notion of there being a typical elementary education student. Indeed, their purpose is to suggest the uniqueness of each person entering the program. These people were but five of the 180 students enrolled in ED CI 216, a curriculum and instruction course in elementary mathematics education, that was the focus of this study (see Appendix 1 for course outline).

An outside viewpoint may be that all the students enrolled in this course shared a common experience by attending the same lectures, participating in the same tests, and preparing assignments based on the same seminars, reading the same textbook, writing the same tests, and preparing assignments based on the same predetermined criteria. This viewpoint, however, presupposes that the experience could be described objectively, even though individual interpretations may have varied. But there is no absolute objective or standard experience against which each individual experience could be placed in comparison. No matter which account would be taken to be such a standard, it would have been conceived from the unique perception of the person who related it. That which was attended to, that which was perceived by any individual, was influenced by the unique world-view of that person. Perceptions were influenced both implicitly through pre-conscious sensing as well as through explicit attending.

This is not to say that among the individual perceptions there were no commonalities. The experiences of the students were indeed interwoven and every individual was a part of the experience of each of the others. Common threads emerged as patterns within a composition which both preserved and complemented the unique. The relationship between the individual and the whole class was co-constitutional rather than comparative.

A traditional research approach would have assumed that certain facets of the course such as the tests or the lectures were the same for all the students; and that, given these controlled factors, other variables such as change in attitude or achievement could be measured. Deviances from the norm would then be attributed to other uncontrolled factors. A phenomenological stance, on the other hand, would assume that all facets of the course were individually perceived and that these unique perceptions would have influenced any measured variable.

As an instructor, my purpose in this study was to gain some understanding of the unique perceptions of the students as they interpreted their experiences in an elementary mathematics curriculum and instruction course. To see through the eyes of the students, even though it may be but a glimpse, would help me to respect and appreciate their individuality and to help them to grow as learners and future teachers. In this study, perception was equated with interpretation of experience, and was assumed to be unique for each person. In this sense, the terms perception and experience were used interchangeably.

Throughout the study, themes emerged from both the individual and the collective experiences of the students. These themes provided the bases from which I wrote the students' stories from their point of view, as well as the bases from which I, as an instructor-researcher, interpreted these experiences with respect to instructor-student relationship and holistic concepts of learning.

CHAPTER II

REVIEW OF THE LITERATURE

The general literature of preservice mathematics education and preservice teacher education was explored. The purpose was to discern the significance of investigating preservice teachers' perceptions of curriculum and instruction courses, and to consider related issues which might be uncovered in the process.

Preservice Mathematics Education

A few definite themes have endured through the past 30 years in preservice mathematics education. The most prominent are educators' anxieties about the mathematics competency and the attitudes towards mathematics of preservice elementary teachers. Because their mathematical backgrounds vary greatly, they likely come to curriculum and instruction courses with diverse needs and expectations. This poses a problem for instructors who wish to address these individual differences, usually over a short term, without putting undue emphasis on content.

Experimental studies (Dutton, 1961; Flexer, 1978; Hunkler & Quast, 1972; Reys & Delon, 1968; Sovchik, Meconi, & Steiner, 1981; Squire, Cathcart, & Worth, 1981a, 1981b) have made important contributions to theoretical knowledge, substantiating that particular factors or settings can influence the improvement of competency and attitudes. In some cases, conjectures have been offered to explain statistically non-significant results e.g. (Flexer, 1978; Reys & Delon, 1968). While these conjectures may be valid, they are interpretations of the researchers whose viewpoints were external to those who participated in the studies, and they usually have been made after the studies have been completed.

Prospective teachers' conceptions of what mathematics is may be at least as important as what mathematics they can do. Without undermining the significance of general and specific competencies, insight into more fundamental perceptions may provide a framework for both presentation and evaluation of content.

Attitudes towards mathematics probably are not separable from competency in the subject, and they both may be tied to the way in which mathematics has been learned. An understanding of prospective teachers' anxieties and their perceptions of these anxieties may provide a starting point for instructors to help build confidence. This, in turn, could provide a model for the future teachers to deal with children who experience frustration when learning mathematics.

Preservice Elementary Education

Efforts to improve preservice teacher education programs have frequently involved practicing teachers, often those just beginning professional teaching. They have been asked to look back on their initial preparation and indicate what, on the basis of their present experience, they felt was most valuable and what was missing in the program.

Koehler (1985), in a recent review of preservice teacher education research, found that practicing teachers generally felt that they were insufficiently prepared in classroom management, instructional strategies, and other special pedagogical concerns. She doubted however, that teachers would ever feel fully prepared for the reality of the classroom, regardless of their preservice training. Similarly, Schuttenberg (1983) reflected the viewpoint of those teacher educators who question whether teachers could ever be equipped with all the knowledge and skills deemed necessary by critics of teacher education programs.

Lasley (1980) reported the results of a year long study of first year teachers' beliefs about teaching. His concern was that beliefs, which are acquired from parents, peers, teachers, neighbors, schools, observation, and folklore, usually persist unmodified unless intentionally or explicitly challenged. Three common beliefs generated were as follows: teaching is a rewarding and fulfilling career; teacher education courses do little to prepare teachers for the real classroom; and people who like children are effective teachers. Lasley said that preservice teachers should challenge their own beliefs about teaching by collecting evidence for and against them. Utilizing research reports, professional journal articles, interviews with classroom teachers, and classroom observations, they should develop and defend a set of belief statements about the nature of teachers, teacher education, and the classroom.

New teachers can provide valuable input for preservice teacher education programs because they are living the experience of becoming professional practitioners. Their perspective is changing; the context of their present experience is primary, and they evaluate their initial training in view of how it gives meaning to their current reality. That which they now consider to be most valuable may not be what they attended to earlier. An understanding of how preservice teachers interpret their program as they are experiencing it, may reveal channels or opportunities for helping them appreciate the significance of aspects of the program which they might otherwise devalue.

Transfer of Training

Evertson, Hawley and Zlotnik (1985) said research indicated that, while many teaching behaviors or skills learned during training are evident during student teaching, they often do not transfer to the classroom when professional teaching begins.

Koehler (1985) said that the links between teacher education programs and teacher behavior are difficult to establish. Copeland (1979) and Doyle (1977) both addressed the concept of "classroom ecology," which is believed to have greater impact on student teachers than does university teaching. Veenman (1984), in a massive review of research looking at general attitudes towards teaching, found that education students experience attitudinal changes in the course of becoming teachers. They tend to be idealistic, progressive, or liberal during their preservice phase and then become more traditional, conservative, or custodial as they move from student teaching into their own classrooms.

This hypothesis was not new. It had been challenged earlier by Zeichner and Tabachnick (1981) who asserted that, while it had become a commonly accepted view, there existed alternative interpretations of the data. The popular notion was that the conservative influence of the schools wiped out attitudes developed during teacher training. One alternative explanation suggested was that university teacher education has little impact on attitudes and does not in fact liberalize. The cumulative, often implicit, and usually conservative conception of teaching which derives from personal experience is perhaps temporarily or superficially submerged during college years, and then quickly recovered with school experience. Another possibility offered was that teacher education actually reinforces traditional ideas; that while the theory expounded is liberal, in practice, the transmission of information model predominates. The authors said there is a need to look more closely at the form and content of teacher education and study the role it plays in influencing prospective teachers' professional perspectives.

Not only does the context of student teaching experience appear to influence the transfer of knowledge and skills from preservice education but the context of this preservice experience itself may be crucial as well. There may exist subtle inconsistencies between the view of learning predicated by teacher educators and that which is practiced in preservice classes. These variances, which are unlikely intentional, may be both perceived implicitly and practiced implicitly by the prospective teacher. Such tacit knowledge can be uncovered, but the context in which it is learned cannot be disregarded.

Perceived Needs

Fuller (1969) wrote that prospective teachers experience conflict between their perceived concerns for survival skills and practical techniques, and the theoretical nature of their courses. Gilliss (1981), writing with respect to educational foundations courses, said the problem is that they are offered at a time when prospective teachers are more concerned with gaining minimal teaching competencies than considering theoretical or philosophical aspects of education.

Katz, Raths, Mohanty, Kurachi, and Irving (1981) talked about the "Feed-Forward Problem" of preservice training. Educators give prospective teachers answers to questions they have not asked and probably will not ask until they are actually teaching. This may cause teacher education students to resist certain learnings while taking courses, and then later complain that these same learnings were not offered or not given enough emphasis.

Book, Byers and Freeman (1983) surveyed students in entry level education courses. Eighty percent had first hand experience working with children as camp counsellors, teacher aides, or Sunday School teachers. They selected on-the-job training and supervised teaching experience to be the most valuable sources of professional knowledge, much more beneficial than preparation in their major field or courses in instructional methods. Rated even lower were educational psychology courses, personal experience, self-directed reading in education, and educational foundation courses. The researchers were concerned that students' expectations would affect their participation in these aspects of the program, and would be difficult to overcome.

Sears (1984) conducted a 2-year ethnographic study to investigate the frames of reference held by students and teacher educators toward the undergraduate teacher education program. He found significant differences between the perceptions of faculty and prospective teachers regarding the quality and effectiveness of teacher training.

Koehler (1985) offered two possibilities for increasing the relevance of preservice coursework. One was that teacher educators must find ways of helping students develop schemas in which they can store various techniques and strategies so that they can later be retrieved and used during actual teaching. The other was that, perhaps, preservice preparation should consider a very different conception of the knowledge and skills which should be acquired. She said there is a need to know more about the cognitive schemas which prospective teachers acquire as they experience teacher education programs. Vaughan (1984) recommended that both teachers and teacher educators, if they are to improve the quality of teaching, must understand and address certain factors, notably the issue of teacher and student expectations and perceptions.

These reports underline the need to consider the perceived needs and expectation of prospective teachers. Recognition of where these are incongruent with the aims of preservice courses can help teacher educators to be prepared to deal with them appropriately.

Need for Student Choice

Vaughan (1984) said that the content chosen by teacher educators, and the methods they use in preservice classes, reveal significant biases about teaching and teachers. Cadenhead (1985) distinguished between the idea of having preservice teachers become more involved in personal development, seeking and organizing for themselves things that affect learning, and the concept of having them shaped by a predetermined competency-based program. While there is need for a structure to help prospective teachers synthesize content and methodology, ultimately their methods must be personally fashioned. He said they must experience discovery and make connections for themselves rather than be receivers of thoughts and information; and they must accept the responsibility which accompanies freedom of thought and practice. This idea is not new. Dewey (1966) objected to teacher education programs which handed out recipes and models for teaching; such practice, he cautioned, greatly discredits pedagogical theory.

Schuttenberg (1983) warned that programs that are heavy with compulsory requirements, that have a low level of learning, and that put grades ahead of learning, make learning distasteful for preservice teachers. He affirmed that in order to gain satisfaction from learning they must be encouraged to set their own goals. From a futures perspective, Tafel (1984) said there are contradicting assumptions between traditional and futuristic views. The former orientation has been that of trainers passing on information to trainees while the latter position necessarily sees education as a personal quest for information. Horowitz and Silas (1970) recommended that the opinions of preservice teachers, because they are based on recent experience with both the theory (through coursework) and practice of education (through student teaching), should be given considerable attention.

Cohen (1983) said that preservice teachers, in attempting to meet course requirements, develop strategies based on their perceptions of what the instructors expect, and put pressure on the instructors to place enough constraints on assignments so that expectations are easily met. This promotes conformity and dependence on the goals of the instructors.

Weininger (1979) asserted that the student who achieves the best grades and who can expect to get the best teaching references from an instructor is one who at least appears to comply with that instructor's style of teaching. This attitude makes little provision for helping new teachers translate theory into new or original practices.

Zeichner (1983) posed some questions, consideration of which he felt was crucial for clarifying the focus of teacher education. These questions addressed the extent to which the teacher education curriculum should be determined in advance or be responsive to self-perceived needs and concerns of prospective teacher, and the extent to which teacher educators should attempt to influence prospective teachers' constructs, attitudes and underlying assumptions and values.

These views concerning course goals have important implications for preservice education. A descriptive study of preservice teachers, as they are involved in a mathematics curriculum and instruction course, could provide some insight into how they interpret their experience, and how they respond to the goals of the course. A number of educators have indicated the direction such research should take.

Need for Descriptive Study

The Research and Development Agenda in Teacher Education (Hall & Koehler, 1979) was established to delineate and give priority to crucial, researchable issues in teacher education. One of the parameters identified in the recommendations resulting from this project was: "A heavier emphasis should be placed on descriptive research (to understand a phenomenon) as a complement to improvement research (designed with intended impact on practice) in order to provide a sufficient base for conceptual and theoretical work" (p. iii).

Various teacher educators have recommended that studies of a descriptive nature will best facilitate understanding of what is actually happening in preservice classes. Champion (1984), in calling for further investigation of preservice teacher education curricula, suggested that a more complete picture of preservice education culture could be sought through participant observations and individual case studies of education courses.

Lanier (1984) said there is a clear need for research and development aimed at improving preservice teacher education, and advised that sound descriptive research rather than experimental study would be the most beneficial way to get such efforts launched. Koehler (1985) regretted that little is known about what actually goes on in preservice classes as such descriptions are rare. She proposed that there may be a greater relationship between what happens in teacher preparation and teaching than is commonly supposed: "We need careful descriptions of program, method, and classroom processes, and their effects on students before attempting to significantly alter existing practice" (p. 28). Koehler (1980) asserted that because teacher education research requires extensive conceptualization, descriptive research should be emphasized initially:

> Descriptive research can provide us with an understanding of the contexts of various types of teacher training programs, on the forces which cause teachers to change--some of which may not be related to teacher training but to, for example, adult development phases; and information on what teachers actually learn from teacher training programs. The latter will be extremely important for criteria setting and measurement, as well as program improvement. (p. 494)

Preservice teachers' perceptions of mathematics curriculum and instruction courses are not widely known; a literature search revealed not one article or research report which specifically addressed this matter. Therefore, this phenomenon is the focus of the present study.

CHAPTER III

THEORETICAL FRAMEWORK

Perception and Learning

In this study, perception is defined in the phenomenological sense as the process by which the surrounding world emerges as meaningful. Misiak and Sexton (1973) state that the success of the phenomenological method in the study of perception is widely recognized. Theoretically, the perceiver is not separated from the perceived and the relationship between the two is the structure of perception. McConville (1978) discussed this structure as a bi-polar subject-world relationship. He said: "When a phenomenologist performs a structural analysis, he looks for the dialectical organization of experiencing-behaving subject and physical-social world which essentially defines the phenomenon in question" (p. 103).

Merleau-Ponty (1962) believes that the essential feature of humankind is the dialectical relationship or dynamic interchange between consciousness and reality, and is achieved and reflected in the perceptual process. For him it is the starting point for the study of human beings and the world.

In the phenomenological method, a phenomenon is approached on its own terms in order to understand and articulate its intrinsic organization as it unfolds in a context or life-world. This life-world or Lebenswelt is the starting point for experience; it is not external to or separate from the person who is living it. The Lebenswelt as the foundation for reflective thought is of a prereflective nature. Valle and King (1978) explained: "In this way then, the Lebenswelt is both independent of knowledge derived from reflective thought processes, and yet, being prereflective (before-reflective), it is also the indispensable ground or starting point for all knowledge" (p. 11).

Meaning comes through consciousness of our Lebenswelt which is initially known at an implicit level. As we structure this experience through reflection we can make our meaning explicit. Symbols and language are involved only at this stage.

Human science does not explain experience through linear cause and effect, but begins with one's lived experience and one's personal interpretation thereof. To understand a phenomenon one must try to withhold one's preconceptions of that phenomenon. This process of "bracketing" begins by acknowledging one's preconceptions and making them explicit. As more presuppositions arise, they too must be bracketed. Bracketing is, in effect, a never-ending reduction of experience by recursive re-examination of assumptions.

Addressing this notion, Giorgi (1970) said that the best way to protect against bias is for the viewpoint to be made explicit. The presence of bias itself is not what invalidates data, but rather it is the extension of this bias to situations where it is not relevant. He explained: "Precisely because man is always in a limited situation, in a perspective, we feel that an engaged attitude which acknowledges such a perspective is a more accurate description than an 'objective' one" (p. 189).

From a phenomenological stance, efforts in this study to explicate the perceptions of a group of preservice teachers began with an eliciting of their unique viewpoints as they experienced (in this case) an elementary mathematics curriculum and instruction course. The personal backgrounds with which the preservice teachers entered the course influenced their perceptions of the experience. Through both spoken and written dialogue, my intent was to act as a catalyst to enable the prospective teachers to identify and examine their own expectations and biases. In order to see through the preservice teachers' eyes, I did not attempt to predict at the outset what would be significant to them. A meta-cognitive awareness of, and sensitivity to, my personal biases, helped me identify and bracket them as they surfaced. The view of perception in this study did not allow for prior identification of all potential biases, but it required that both I and the preservice teachers constantly monitor observations and interpretations.

For the four years immediately prior to this study, I taught the mathematics component of the courses ED CI 215 and ED CI 315 (see Appendices 2 and 3 for course outlines). The content and goals of these components were comparable to those of ED CI 216. During this time I formed certain perceptions of the students with whom I interacted. For three successive terms I conducted informal surveys of the students' expectations of a mathematics curriculum and instruction course. In each case, the students indicated that, predominantly, they hoped to learn teaching methodology. The data also indicated that many found mathematics difficult and held negative attitudes towards the subject. The latter finding was consistent with the general literature of preservice mathematics teacher education.

I felt that many of the students were competitive and anxious to conform to my expectations when preparing assignments and studying for tests. I also felt that many students who began the course with great mathematics anxiety developed more positive feelings after participating in concrete learning activities which emphasized understanding rather than rote symbolic learning and application. I believed that the majority of the students were sincerely concerned about helping children learn mathematics and making it an enjoyable experience.

As an instructor, I knew what goals I believed were important and planned lectures and activities which I felt would help students attain these goals. What I did not know was how the students perceived my goals and whether they truly shared or accepted them. I wanted to view the course and construct the experience from a student perspective. As an instructor, I could not deny my own perspective, but hoped that by establishing a trusting student-instructor relationship the students would be able to explicate and share their perceptions.

Consistent with a phenomenological approach to perception are holistic conceptions of learning. For example, Colaizzi (1978, p. 125) identified genuine learning as: "that activity whereby the learner extracts from his learned content, which is a meaning-idea of which he had no previous knowledge and which he posits as true." Genuine learning cannot be preprogrammed, nor does it linearly connect cause and effect. When it occurs, there is a total modification of how an individual's life-world is personally interpreted.

Similarly, Osborne (1985, p. 195) discussed learning as "a change in world view", which he described as "a broad holistic, physiognomic process." While a change has a profound effect on an individual's lived experience, it may not be observable to others. The process is one which modifies existing world views; a changed view is not totally disconnected from the previous one. This concept of modification is congruent with the notions of reflection and recursion suggested by Sawada and Olson (1986). Recursion implies that each state of being is a transformation of the previous state: recursion is the process and each new state is the reflection or product.

The conceptions discussed so far convey the need for readiness or intention to learn or let go of old views; and the change, once completed, is irreversible. These notions are also features of Dabrowski's (1964) theory of positive disintegration, and of the personal construct theory of Kelly (1955).

These examples are but a few of a growing number of holistic theories of learning. They all represent recent attempts to portray learning as a qualitative process and are intended to complement rather than displace traditional behavioral and cognitive theories of learning. While different terminology is employed, these theories do share certain characteristics.

Holistic learning is not simply linear ar additive, but is a qualitatively different way of being and knowing. The process is irreversible and continuous throughout an individual's lifetime. It can neither be measured nor controlled from outside the learner, and for each person the learning is unique. Each state implicitly influences what a person perceives as the truth. Once order is established, there is a strong tendency for preservation. The existing order attempts to make new information fit in. When contradiction is sensed, the tendency is to reject it, and thus a person maintains security of basic beliefs. When opposition is strong enough, a person may choose to challenge the existing order by making it explicit and scrutinizing it. If the existing order is then found inadequate, it must be rejected. This can be a precarious experience because letting go of a belief means confronting confusion and uncertainty.

While change may appear to occur suddenly as the result of a specific experience, in fact, such an experience would be a climactic point in the process. The order which characterizes a new stage is not totally discrete from the preceding one, but a qualitatively different reordering or reconceptualization. These holistic characteristics of learning go beyond conceptualizing learning as acquisition of information, cognitive organization, and memory. In this sense, they allow for what may seem unexplainable about the uniqueness of thought.

Teacher as Researcher

According to Simpson (1966) the basis for rational change in teaching is self-evaluation. This entails a systematic allocation of both effort and time in areas where the teacher feels change will be profitable. Self-evaluation can help to define a teacher's role and avoid boredom. He suggested that teachers assess their own teaching in writing, self-diagnosing strengths and weaknesses. This technique, practised daily or each term can provide a basis for modifying goals, procedures, assignments and materials. Student evaluation, whether by class survey or individual interview, can help the teacher develop tolerance and the ability to seek and accept criticism. The teacher as a learner must be willing to view learning and professional growth as a life-long process of becoming. In this study I engaged in written self-evaluation by means of a daily journal. At the end of the course, all participants were given the opportunity to present the instructors with a general written evaluation. Interviews were held throughout the study, and I dialogued with the five main participants through journal writing. This practice was discussed by Roderick (1984), who saw herself and her students as being engaged together in coming to understand what it means to be an educator and to be educated.

Silver (1982) posited the necessity of self-analysis for awareness of preferential behaviors, and the avoidance of imposition of personal beliefs and idiosyncrasies on others. By becoming aware of one's own preferences for content and learning style, a teacher can become more effective and open to the values and learning preferences of students. Self-knowledge provides a starting-point for change.

The dichotomy between teacher and researcher is arbitrary, based on a metaphor which necessitates stepping outside oneself in order to reflect upon oneself. Sawada and Olson (1986) discussed the fallacy of this model which sees the world as consisting of objects separated from their environment. The phenomenological view of perception discussed earlier makes no such distinction. The wholeness ontology offered by Sawada and Olson explained how the separation of objects from the whole is a descriptive act of an observer, and not the inherent reality of the objects themselves.

Freire (1983) explained how, through dialogue, teacher and students as separable units cease to exist and the "teacher-student with students-teachers" emerges. The teacher is taught while teaching in a growth process of joint responsibility. He further explained: "Hence, the teacher-student and the students-teachers reflect simultaneously on themselves and the world without dichotomizing this reflection from action, and thus establish an authentic form of thought and action" (p. 71).

Freire (1983) also discussed the notion that it is inadvisable for people to be involved in the search for their own meaningful thematics. He said that the view that findings in such cases would be adulterated presupposes that the themes exist as things outside people, whereas they exist in people as they relate to the world.

Friere's ideas can be related to the concepts of recursion and reflection as embraced in the system of conversation as described by

Sawada and Olson (1986). In a conversation, participants interact recursively, acting as perturbations upon one another. A perturbation does not serve as an input but disturbs a person's equilibrium. As the recursive action drives the system far from equilibrium, the participants, through reorganization, emerge at a new level of equilibrium. The product of this recursive process is reflection. When conversing with others, a person implicitly engages in self-conversation, simultaneously. Within the model presented, this would be seen as self-awareness.

In this study, the dichotomy between teacher and researcher was not seen as problematic. In fact, the stance was taken that the two roles were not separable.

Culture and Ethnography

Spradley (1979, p. 5) defined culture as "the acquired knowledge that people use to interpret experience and generate social behavior." A cultural group is one in which the members share artifacts, behavior, and knowledge. People learn culture by making inferences about the behaviors they observe and the way artifacts are used.

The qualitative research procedures of ethnography have been used extensively by anthropologists in their work of describing other cultures. While anthropologists are typically associated with the study of people living in parts of the world remote from ours, the value of their methodology for studying cultural subgroups within our own society increasingly is becoming recognized by sociologists and educational researchers (Burgess, 1982; Popkewitz, 1980; Spradley, 1979; Werner & Rothe, 1980; Wilson, 1977).

Wolcott (1975) claimed that an ethnographic approach can be used to study virtually any aspect of human social life. He said, however, that most work that is labeled as ethnography would be better described as making a contribution towards the ethnography of the culture which was studied. The completeness of an ethnographic account may be judged on the basis of how well a person reading it could then behave as a member of that culture. In this sense, many studies are more appropriately called case studies. Although ethnographic techniques are employed, the studies are concerned with relatively small culture-sharing groups, and the time spent conducting them is usually months rather than years.

Ethnographic methods have been employed recently in teacher education studies. As participant-observers, Tardif (1984) looked at the experience of student teachers; and Craig (1984), Everett-Turner (1984) and Hawke (1980) sought the perspectives of beginning teachers. In this study, which involved participants in a preservice curriculum and instruction course, the researcher was one of the instructors of the course.

Honigman (1982) said that almost every person, event and artifact which belongs to a common system reflects a common culture. Subgroups can be sampled and the information obtained can contribute to the whole system. This was a case study which employed ethnographic fieldwork methodology, and elementary preservice teachers who were enrolled in one section of a mathematics curriculum and instruction course were considered as a cultural group. They, in fact, formed a subgroup of all elementary preservice teachers who were enrolled in the course.

CHAPTER IV

DESIGN OF THE STUDY

Purpose of the Study

The purpose of the study was to describe how preservice teachers experienced an elementary mathematics curriculum and instruction course. Data collected from the five main participants as well as that collected from all students enrolled in the course gave rise to descriptive themes. These themes provided the bases from which the students' stories were told, from their point of view, as well as the bases from which I as an instructor-researcher interpreted the experience with respect to instructor-student relationship and holistic concepts of learning. Some understanding was sought with respect to the following questions.

1) What did the preservice teachers hope to learn in an elementary mathematics curriculum and instruction course?

2) How did these expectations relate to what the preservice teachers felt they had learned when the course was over?

3) How did the preservice teachers interpret their participation in course activities and fulfillment of course requirements?

4) What did they perceive as meaningful and how did they feel about their experience?

5) Was there evidence that the preservice teachers' perspectives changed over the short term of the course?

6) What was the nature and significance of the instructor-student relationship?

Significance of the Study

Koehler (1980), in discussing quantitative and qualitative research, said that methodologies are closely tied to purposes. Expanding on the purpose of descriptive studies, which is to understand or produce knowledge about a phenomenon, she wrote:

> In a descriptive study, there is no explicit statement of criteria of effective, successful or good processes. The aim is theory development to be used in understanding what is happening, and/or how or why things happen the way they do. There is no direct or logical relationship between the results of a descriptive study and prescriptions for change; nor, in most cases, is there meant to be (p. 486).

Hamilton (cited in Koehler, 1980), said that generalizability is in the eye of the reader. He suggested that research is generalizable to the extent that someone understands and finds helpful, the situations, contexts, behaviors, and understandings arrived at and described by the researcher.

Koehler (1980) addressed the difficulty of predicting, at the proposal stage, how descriptive research is related to the improvement of practice. She said: "Better understanding of one's own situation, and knowledge of learning processes, can improve curricula and instructional procedures; but the direction of the change itself is not prescribed by the research" (p. 491). She stated that descriptive research can provide conceptual clarity. While it is not necessarily linearly related to improvement research, it can generate important hypotheses for improvement researchers to test.

Setting of the Study

This study took place during an elementary mathematics curriculum and instruction course offered from September 8 to November 14, 1986. The Fall term for courses such as this one normally consisted of 13 weeks of classes, followed by examinations, but was compressed to 9 weeks of classes and 1 week for examinations for those students required to participate in a 4-week practicum from November 17 to December 12. This was to be the first student-teaching experience for these students whose previous field experience had been at an observation level. They would be assigned to their major 8-week practicum the following February.

ED CI 216, Curriculum and Instruction in Elementary Mathematics, is a 2-credit course. All elementary education students are required to take a mathematics curriculum and instruction course, either this one or a component in a 9-credit curriculum and instruction course which also included art, science, and movement. (At the time of the study, this 9-credit arrangement was being phased out in favor of discrete 2-credit courses.) Each student also was required to complete a mathematics course outside the Faculty of Education. Courses which satisfied this requirement included courses from the mathematics, statistics, and computing science departments. Most students took MATH 261 which was designed especially for education students.

The schedule for ED CI 216 involved two one-hour lectures and one one-hour seminar each week. The 180 students registered in the course attended the lectures as one large group, on Monday from 3:00 - 3:50, and on Tuesday from 12:30 - 1:20. The students were then divided into five seminar sections which met as follows: Wednesday - Q1, 9:00 - 9:50; Q2, 10:00 - 10:50; Q3, 11:00 - 11:50; and Friday -Q4, 9:00 - 9:50; Q5, 10:00 - 10:50.

The instructors for the course included a professor who served as course coordinator, a sessional instructor, and myself, a graduate teaching assistant. Though we all presented lectures and supervised seminars, I was predominantly the seminar supervisor and the others were the principal lecturers.

I was not directly involved with course evaluation. While I monitored attendance at seminars through collection of weekly lab summary sheets, and contributed examination questions, I neither marked examinations or assignments, nor determined grades. The rationale for my non-participation in evaluation was that getting a good grade might have been so important to the students that it could have affected the credibility of the data collected. This proved to be a wise decision.

Selection of Participants

All 180 students enrolled in ED CI 216 were part of the study in a general sense. My research plans were briefly explained to them at the first lecture, and in more detail in the seminars. As instructor-researcher, I interacted with all the students, and data in the form of lab summaries was collected from each student every week. I also encouraged them to talk with me about any aspects of the course they wished.

The main participants in the study were selected from the large group after the course had begun. Originally, I had hoped to have all the main participants from one seminar class to facilitate meeting with them as a group if the necessity arose. The Q2 section was initially chosen as it was the largest seminar section at that time. I explained the purpose of my study and why I was asking for special participants. Only four people volunteered, so I repeated my request in the Q3 section, and two more students agreed to take part in the study. Each of these six participants signed a consent form which indicated their willingness to participate according to the terms stated (See Appendix 4 for consent form). Five people continued as active participants throughout the study, but one chose to withdraw form the study though she remained in the course.

Data Collection

Seminars

There were nine seminars, during the course, each of which focused on a different topic, as follows: curriculum, problem solving, number, numeration, computation, fractions, decimals and calculators, geometry, and measurement. At the end of each seminar, the students were required to complete a lab summary sheet (See Appendix 5 for sample sheet). The purpose was to help them reflect on the day's activities, noting observations, implications, and insights which they felt were significant to them as learners or future teachers of mathematics. A change, based on students' comments was made in the summary sheet after three weeks. The sections for implications and insights were combined as a number of students expressed difficulty in distinguishing between the two. As part of the course requirements, credit was given for class participation and completion of these sheets, which were not graded. All but two students gave consent by way of signature to allow statements from their lab sheets to be quoted in the dissertation (See Appendix 6 for consent form).

Journals

As well as keeping a researcher journal myself, I undertook a journal dialogue with the five main participants which I believed would be of mutual benefit to them and me. Because they made a generous time commitment, I felt they should derive personal gain from the experience. Prior to beginning, four of them were available to meet with an expert in journal writing to help them understand the process and purpose of keeping a journal. The format suggested was similar to the method developed by Craig (1983) for use with preservice teachers. It consists of three parts. One side of the page is used to record what was done in class or course related activities done outside of class. This part of the journal is sequential, cumulative and structured. Reflections or reactions to this part are written on the other side of the page. This part involves criticism and evaluation and has implications for the instructor. The participants were encouraged to develop a format and style with which they felt comfortable. This meeting was stimulating, and helped the students to get started.

Personal contact was limited due to the short term, and I wanted to be in touch with the students' experiences as they lived them. Both from past personal experience of using journals with preservice teachers, and from the writings of others, I believed that journal writing was an appropriate method. Roderick (1984) described her use of dialogue journal writing with her preservice students as a "collaborative effort." As well as getting to know her students as persons and helping them to know her as a person, her purpose was "to obtain insights that could form the basis for planning a professional experience focusing on teacher as person" (p. 2). Schuttenberg (1983) suggested that, by keeping a learning analysis diary, preservice students could compare theory and practice in human relations. Burton

(1985) proposed writing as a way of knowing in a mathematics education class:

> Free writing is but one of the powerful writing-based strategies useful in preservice or inservice mathematics education courses. Writing in journals is another technique that costs no money and little time but yields copious benefits in the quality of class time (p. 41).

I had hoped to collect, read, and respond to the journals each week. In practice, due to the heavy workload of the compressed term, I received the journals less frequently; but in order to keep continuity, I returned the journals within one or two days (See Appendix 7 for journal excerpts).

Interviews

Interviews generally have an important place in research which employs ethnographic methodology. While they are often conducted with an explicit purpose and direction, they have many similarities with friendly conversation. Traditionally, an ethnographer "steps into" a cultural setting which is on-going and independent from the researcher, and may spend years gathering data. In this study, the experience of students participating in ED CI 216 was temporal and I was part of that experience.

My main purpose when interviewing students was to encourage them to talk about those aspects of the course which were important to them at the time of the interview. I did ask them about their goals for the course, what they felt they learned, or how they felt about teaching mathematics; but I let the interview take a natural course much like a friendly conversation. In this sense, the interviews could be described as phenomenological encounters.

I conducted one audio-recorded interview with each participant at their convenience. Casual interviews with both the main participants and other students in the course took place in the lecture theatre or seminar room after class, in my office, or sometimes in the student lounge area. They included both private and small group discussions; and due to the context and impromptu nature these conversations were not taped.

Reliability and Validity

Ethnographic studies, according to Wolcott (1975), are descriptive or theory-producing rather than experimental and theory-testing. Stake (1978) said that case studies are expansive rather than reductionist as they proliferate rather than narrow a knowledge base. He stated that they are best suited to adding to existing experience and humanistic understanding. Good ethnographic work is rigorous and demanding, but its fundamentally different approach requires that it seek credibility on its own terms rather than applying the strictures of experimental research. Qualitative researchers have developed a number of strategies to establish the credibility of their work. Discussions of the problems commonly associated with reliability and validity appear frequently in the literature.

All facets of reliability and validity can be considered at the outset of a qualitative study, but their identification and methods of resolution cannot be guaranteed. The tentative nature which is fundamental to ethnographic methodology requires that credibility be continually audited throughout the study. In the present study, some techniques were established to address both reliability and validity.

Reliability

Werner and Rothe (1980) said that reliability requires that a study can be replicated, and that when replicated the results will be compatible with those of the original study. Because replication depends on clarity of purposes, assumptions, and procedural details, qualitative researchers should describe the purpose of the study and the major question they want to address. The purpose and guiding questions of the present study were outlined earlier in this chapter. The methodology [illegible] this research is replicable, but as a case study the resulting description will have many unique features.

The details of qualitative research are difficult to spell out before the study begins. Wolcott (1975) addressed the strictures of proposal writing which can place restraints on problem identification. He said that the researcher should be able to "muddle about in the field," pursuing directions and problems which arise and appear significant. Smith (1979, p. 331) discussed Malinowski's notion of foreshadowed problems or "provisional ways of knowing" which reflect an awareness of existing problems and issues in the area of the study.

Wilson (1977) described the grounded theory of Glaser and Strauss as an open approach where the tension between participant data and observer analysis is used to constantly refine theory. Detailed chronological notes of procedural methods were kept and are carefully explained in this dissertation.

As advised by Owens (1982), I maintained a file throughout this study to include all materials from the site which are related to the findings and interpretations. This data collection facilitates preservation of the study context for both analysis and replication of the study.

LeCompte and Goetz (1982) discussed aspects of external and internal reliability. External reliability requires that the researcher's role and status in the study be clearly identified; criteria for choice of informants be carefully delineated; there is a clear description of the social context of the study; assumptions and metatheories which underlie terminology and analytic constructs are explicitly identified; and there is a clear description of procedures used to collect and analyse data. In this study, I was one of the course instructors of the participating preservice teachers, and this made initial entry into the field relatively simple. While good rapport was sought to facilitate the acquisition of valid information, the interpretation of that information was from my perspective as an instructor-researcher. The criteria for choosing the main participants were delineated earlier in this chapter. Data were gathered under a number of conditions including the varied atmospheres of large lecture groups, small seminar groups, private interviews, and informal chats. Descriptions of the contexts have been noted and reported. The importance of sampling a wide range of participant experience and contextual interpretation has been noted also by Wilson (1977). Perception and learning, the teacher as researcher, and culture and ethnography, as they pertain to this study, have been discussed in the previous chapter. The categories for coding data, however, were not predetermined. Data collection has been discussed in this chapter, and analysis of data is detailed in the following chapter.

Internal reliability can be enhanced by use of low-inference descriptions, multiple researchers, participant researchers, peer examinations, and mechanically recorded data. Both concrete, precise descriptions of situations and behavior, and verbatim accounts from participants were included in field notes. Observing confidentiality, I regularly discussed my observations and interpretations with the other two course instructors. The purpose was to identify possible researcher biases or influences. These have been referred to as "blind spots" by Wolcott (1975, p. 116). During discussions with both the main participants and other students, I encouraged reaction to, or verification of, information received from their peers. This dissertation, which was read by the other course instructors, will serve as a medium for peer examination. Permission from the main participants was received to audio-tape the formal interviews. This served to record and preserve raw data for later analysis.

Validity

Werner and Rothe (1980) said that during fieldwork, ethnographers must compare reports given by the participants and the researchers' descriptions must be verified with the participants. Throughout the study, I presented to all seminar classes my observations and interpretations arising form the lab summary sheets. I invited comments from the students, explaining to them the importance of data confirmation. When I had finished writing the student themes, I presented them to the five main participants for verification of my interpretation of their experience.

LeCompte and Goetz (1982) offered a number of points to be considered with respect to internal and external validity. Internal validity requires that the researcher must establish which data remain stable over time and which data change; take into account the behavior of the observer and the effect it has on the participants; establish contact and maintain relationships with as diverse a group of people as possible; be aware that loss of participants and entry of new participants during the course of the study can cause important changes in the group; and avoid making spurious conclusions.

Effects of history and maturation are central to the study. As the course progressed, changes in the attitudes and expectations of the preservice teachers were monitored through observations, interviews, and journals. As both researcher and one of the instructors of the course, my relationship with the preservice teachers had informal and formal dimensions. My role as instructor may have affected the credibility of the data gathered. For this reason it was crucial that I establish early an atmosphere of trust. Wilson (1977) indicated the necessity for the researcher to empathize with participants to uncover hidden meanings and synthesize observations made. Selection effects were not of prime concern. While there were only five main participants, all 180 students were observed, contributed some data regularly, and had access to informal interviews with me.

Change of group membership posed minimal difficulty because this study focused on participants for the duration of one term only. Group membership stabilized early in the term; one person withdrew as a main participant but remained in the course. Due to the relatively short span of the course, I had to carefully guard against spurious conclusions. This required constant validation of conclusions with the participants and critical examination of data to identify sources of bias. Wilson (1977) stated that researchers must become sensitive research instruments by transcending their own perspectives and becoming familiar with the perspectives of those being studied.

External validity may be influenced by a number of effects: selection effects which occur when constructs are specific to a single group or a function of the investigative setting itself; the unique histories of groups which might make cross-group comparisons invalid; and construct effects, which may be due to the techniques used to elicit data.

The categories for coding the data arose from the data and were not predetermined by the researcher. While this enhanced the validity of the constructs for the group being studied, it does not guarantee external validity. External validity in this respect can be viewed in light of Honigman's (1982) notion of subgroups reflecting a common culture. Setting effects can be neither totally avoided nor ignored. In this case, I monitored interactions and observations, being sensitive to findings which may be due to the participants being under investigation. The participants in this study shared some commonalities in their backgrounds, and they certainly shared the political, social, and economic milieu of the time of the study. Such unique elements, which could not be controlled or replicated, were described. Construct effects were compensated for through triangulation, the use of a variety of data sources. These included surveys, student and researcher journals, observations, lab summary sheets, course evaluations and interviews.

Easley (1982) addressed the notion of generalizability. He suggested that it is an intuition which allows one to know when to interpret a phenomenon in light of a particular theory. It involves the ability to recognize relationships and be able to choose appropriate applications.

CHAPTER V

ANALYSIS AND DISCUSSION OF DATA

The major model used for data analysis was the Developmental Research Sequence presented by Spradley (1979, 1980). The data were analyzed continuously throughout the study. Every week, all comments from the lab summary sheets were recorded, and similar observations and reflections were grouped and coded descriptively. For example, some categories which arose from the curriculum guide analysis seminar were content of the guide, nature of the guide, usefulness of the guide, and affective considerations. As the term progresses, similar categories were identified in other seminars, such as variety of materials, value of hands-on approach, and reflections on personal early learning. I presented summaries of the analyses to the other two instructors at weekly meetings and to the students at the beginning of each seminar.

While no formal analysis of journal writing was done during the study, continuity was supported by the dialogue form. This facilitated interchange of ideas through successive entries made by the students and myself. The interviews, both formal and informal, also gave me opportunities to verify or validate interpretations of data from all sources. When the course was over, the course evaluations, which had been kept sealed until final grades were posted were added to the data (See Appendix 8 for evaluation sheet).

Domains (categories of cultural meaning) were identified and further categorized during and after collection of data. For example, the students distinguished between lectures and seminars; among requirements such as assignments, examinations, and text readings; and between instructor and peer evaluation. Examination of the similarities and differences among these categories revealed patterns from which emerged the themes.

Spradley (1979) defined a cultural theme as "any cognitive principle, tacit or explicit, recurrent in a number of domains and serving as a relationship among subsystems of cultural meaning" (p. 186). The importance of control emerged early in the data analysis. Dichotomies between learner and teacher, expectations and lived experience, and past and present learning also appeared to be significant.

Three major themes--Getting Through the Course, Feeling Prepared to Teach Mathematics, and Looking for Models--were chosen to describe the students' experience through their eyes. My interpretation of their experience, as an instructor and researcher, was presented through the themes of Learning and Control. Once these themes were established, all data including journals, interviews, seminar summary sheets, and final course evaluations were coded accordingly. The data for each theme was then analysed for organizational sub-themes, and sub-coded respectively. Each theme, then, was presented descriptively.

Student Themes

Getting Through the Course

This theme arises from the needs and expectations which are associated with being a student. While such concerns are ever-present, their intensity fluctuates, and generally increases as the course progresses. Struggling with time constraints, fulfilling course requirements, and coping with the pressures of competition can put goals related to teaching on hold; they are on-going, but the course is terminal. For example, the effects of grades received for tests and assignments are often immediate and emotional, especially if students feel they have not received fair returns for their efforts. Even when they separate the grade received from what they feel they know, they see the grade as the long-term and irreversible determiner that really counts.

When I asked Bob, early in the term, whether he had any goals for himself when he started the course, he was quick to reply, "A good mark, of course!" Certainly, Bob had other goals, but he held a good academic record and maintaining it was of utmost importance to him. Students want to do well both for the sake of personal accomplishment and for the ultimate purpose of securing a teaching position. The former aim is pursued in accordance with how capable individuals feel they are and the strength of their inner motivation, while the latter involves vying with others, including their classmates, in a competitive job market.

Jennifer and Lorna shared similar feelings with Dianne who said: "I didn't have a successful math background and so I was a bit worried about it." Motivation to overcome their own anxiety came largely from their qualms about passing it on to their future students. Lorna worried: "It is only obvious that my own feeling will somehow surface while teaching math." They all worked hard and Jennifer expressed satisfaction with her progress: "I got sevens on both of them [exams] and I'm happy with that." Personally, Lorna felt good about what she learned in the course which she described as "one of my better CI's," yet admitted: "The competition is there . . . and it's not dependent on just what you do, can do yourself." Though he experienced some difficulty with problem solving, Bob had confidence in his ability to learn and teach mathematics. "I made honors last year," he said, adding: "I was quite pleased with myself." He hoped to keep up his grades and felt that his prospects for employment were "excellent." He acknowledged that others were concerned about competition and said they would fight for one point.

Probably it is not possible to entirely separate feelings of satisfaction or disappointment with grades received from overall feelings about the value of a course. There are, however, a number of factors which students identified as affecting their efforts to get through the course.

Workload

The workload in a course is usually of major concern and in this case it was accentuated due to the time element. Most students were taking four other courses which were also compressed in the ten-week term. Generally, students were satisfied with the requirements of ED CI 216. Lorna found that it was "evenly distributed and well-paced" for Jennifer it was "manageable," and others described the workload as "fair," "appropriate," or "reasonable."

All students, though, felt pressures related to the short term, especially those who had other significant responsibilities. Bob felt continually exhausted and expressed guilt about wasting time, saying, "And then I'll just sit there and not do anything even knowing I should be doing something, and that just adds to the burden." To help ease the pressure, he gave up his early morning paper route about halfway through the term.

Helen was also frustrated by not having enough time to learn, labeling the curriculum and instruction classes that she was taking as "crash courses." She voiced her disappointment explaining: "There's an awful lot there that I think should be spread out a little bit more. I can see this as being a year's program." Dianne found the term hectic, but also enjoyable. She said, "I don't really want it to end. Ten weeks is such a short time for any course, especially when you have it for a mere two or three hours a week." In comparison to the curriculum and instruction courses that she took last year, Jennifer felt that there was less time this term to cover the same amount of material. Her concern was: "I probably won't have any opportunities to think about all these things that we've done in such a short amount of time." She contended that there were times, too, when the demands of other courses had to take precedence and she had to "put math on a shelf for a bit." Jennifer also mentioned the stress of having one or more exams on the same day.

Illness can be particularly perilous during a compressed term. Lorna had to contend with this problem, but she was fortunate not to miss many classes. Jennifer managed perfect attendance for the course, but was unwell while studying for and writing one test. There were many others who either struggled to attend or who were absent due to sickness.

The difficulty of accommodating everyone was evident when, due to timetable restraints, the last seminar session was scheduled to facilitate convenient use by the students. The lab activities were made available from Monday through Friday, from 8:00 a.m. until 3:00 p.m., even though officially, classes ended on Wednesday. Most students felt the arrangement was reasonable and were grateful for the flexibility it allowed them. A few from the Friday seminar section, however, were displeased. One student objected: "Something should be done so that all the labs can be scheduled within the course time allotted. The time period after classes has been allocated for studying for finals and should be respected as such!"

While management of time is a perennial problem for students, the compressed term heightened anxiety, which seemed to increase as the term progressed, and assignments and tests accumulated. These students were also anticipating their first major practicum, which was a further cause of apprehension.

Class size

Another source of distress to students was the size of the class. Bob mentioned this often. He contended that he felt a loss of "joy" in the large class, comparing the situation to his experience last term. He said:

> I felt a lot closer to the teachers in the [CI classes last year] than I do now . . . that was the main reason why I volunteered for your study--because I knew I'd get to know you more and be able to sit down one-on-one, and if I had a problem I could come up and say, 'Hey, I've got a problem' and I'd get a favorable response.

Jennifer, too, felt that being part of the study was helpful, considering the large number of students, and that her participation made going to class "a lot more personal."

For Helen, the lack of interaction was a big disappointment. She said:

> This year the classes are so much bigger, and I think they're really missing the boat with student-professor and student-student interaction. I miss that--I miss saying, 'O.K., well what happens in this situation?' You can't do that in a lecture theatre with 200 kids in there--you can't do it! The professor doesn't want it and everybody else--all they want is to get out of there. It's not beneficial to learning--it isn't!

Others expressed reluctance to ask questions during lectures, and admitted finding it difficult to approach instructors. In one instance, a student regretted: "I really dislike the CI's this semester. The classes were very impersonal, I never felt comfortable talking to my profs because they didn't know who I was nor did I know them well enough to have meaningful discussions."

There was mixed response to having three instructors. Some students reacted positively through statements such as: "The team-teaching . . . added variety to the course," and "I liked different profs--nice change." Others voiced displeasure, describing the approach as "confusing" and "bit-n-pieces oriented." One student asserted: "Perhaps there should only be one lecturer. . . . The speakers had very different styles and this meant the difference between paying close attention and not."

Comparison of this class with the 9-credit CI course was inevitable because that was the form in which most of the students previously had taken curriculum and instruction courses. Those classes last spring had enrollments of about 30 to 40 students, and ran for a full term. Both these circumstances are more conducive to the development of interpersonal relationships. Those students who had transferred from regional colleges were also accustomed to smaller classes, and found the adjustment difficult.

Opportunity to personally communicate with professors, then, is considered essential by most students. Furthermore, opportunities for satisfactory interaction seem to be hampered by large classes. Feelings of alienation can result, making the experience of getting through the course very frustrating.

Lectures

The lectures were presented in ED N2-115, a multi-media theatre which seated about 200 people. As there were 180 students in ED CI 216, there were few empty seats when everyone was present. While Jennifer described it as "the most comfortable lecture auditorium I've been in," there were some drawbacks. Students who arrived late often sat on extra chairs at the back, or on the stairs because it was too awkward to take an empty seat without inconveniencing others.

There was considerable distance between the lecturer and the students, and the size of the room made it necessary for the lecturer to use a microphone. The setting, then, did not lend itself to interaction between the students and the instructor; rather it was basically limited to one-way communication. Discussion among students was neither convenient nor appropriate. In fact, whispering and talking was a source of distraction, most often noted by those who sat near the back. For example, one student complained: "The class sessions tended to drag and I often noticed people passing notes between themselves to bide the time"; and then added: "I appreciate the lecture problem when one has such a large class."

As it was difficult to display materials and use them in demonstrations, the overhead projector was usually used as part of the presentation. Students sitting in the side rows sometimes protested that the screen was difficult to view. A problem with using transparencies is that many students feel the need to record every detail. As a result they become frustrated trying to read, listen, and take notes, especially if they are experiencing auditory or visual problems. One student was severely hearing-impaired, but she always sat at the front and usually had an interpreter present. Two other students volunteered, on the first, day to take notes for her. She compensated very well and never complained.

Clearly, some students perceived the above constraints as being more problematic than others. General comments about the lectures ranged from unsatisfactory descriptions such as "a waste of time," "poor and not well planned," "dull and boring"; to compliments like "interesting," "well organized and presented," and "presented in a good manner and easily understood."

Seminars

The seminars, more popularly called labs, had about 40 students to a section. They were held in a classroom where the students sat at tables in groups of five or six. The classroom was located near the mathematics storage area, which was convenient for the transportation of materials. The room, however, was long and narrow, making movement awkward once people were seated. It was difficult for the instructors to mingle and attend to individual questions, and for the students to change positions, especially during rotation labs.

The labs usually focused on materials and hands-on activities which were suitable for helping children learn mathematics. A handout was provided to accompany the materials, and the purpose was not just to complete the activities, but to think about using them with children. Because participation in seminars was considered fundamental to the course, it was worth 20 points.

For some students, like Jennifer, the labs were a "saving grace to complement the lectures," an opportunity for more personal interaction. She wrote in her journal:

> I think I would be very frustrated if my only opportunity to be in the presence of an instructor was during a lecture. I listen and take notes and read my text and save my questions for lab time to discuss with my lab partners or you. Labs are great--I wish we had more time for a 2-hour lab because 50 minutes goes by so quickly.

Jennifer's comments were echoed by other students who enjoyed the seminars, but felt there was not enough time to complete the activities or engage in discussion.

At the end of each lab, students were required to fill out a summary sheet. The purpose was to foster reflection on the day's activities and to record observations, implications, and insights pertinent to the learning and teaching of mathematics. These sheets were then collected and returned at the next seminar. Some students were skeptical of the value of this exercise. This attitude was exemplified by one person who suggested: "The labs were interesting, although those lab evaluation sheets were boring and not very thought provoking--not much work put into those!"

Unfortunately, some students equated participation with attendance, and viewed the seminars as a "waste of time" or "too simplistic." They admitted that they attended "only to get marks," and complained that it was "ludicrous" to get 20 points just to "show up and visit" and "fill in a form." Dianne addressed this problem. She thought the labs were a good idea because "you could actually come in here and work," but felt it was up to the student to make the lab time worthwhile. She was concerned about those who did not, saying:

> You could come in here and just sort of do nothing and not really learn anything if you decided you wanted to, but if you were thinking about what you would do with the child, you know, they were very useful.

Her opinion was shared by others, as one student expressed: "If you did make the effort to go to the lab, you were rewarded. Each individual benefitted in their own way."

The value students placed on the seminar sessions, it seemed, reflected their attitude towards the nature of the activities. For some, it was a matter of putting in time for credit; yet for others, there was never enough time.

Assignment

One assignment was required for the course. It entailed preparing a set of activities for the development or reinforcement of one or more concepts involved in fractions, ratio, or percent. While students generally felt that the project was "a good idea," a number of concerns arose. These included requirements of the assignment, group work, weighting, and peer evaluation.

Students had a strong need to know what was expected. The sheet describing the assignment was distributed on the first day of classes. After being given a chance to read it over, students were told that they would probably have a better idea of how to proceed after they had

had a chance to participate in a few seminars which would provide models for suitable activities. When given an opportunity to ask questions the first one was, "How many are in a set?" As the term progressed, there were many more queries which focused on details of requirements, such as format for directions, length of activities, and amount of materials.

Shortly after the first test, Helen made some inquiries about the assignment. She did not feel she had a clear idea about it and said that others were having the same problem. When I asked her what was causing the confusion, she replied that there was uncertainty about "just what is expected." Specifically, she asked whether it should be a sequence of activities, where it should "stop," and what format should be used. She explained: "For some people, 10 points are very important after the exam."

Students sometimes were hesitant or even apologetic when asking about requirements. For example, Dianne wrote in her journal: "I'd like to ask about the project. I know that you don't want to guide this project really closely but I must ask one question." This indicated that while she wanted to proceed independently, she felt anxious about doing the right thing.

Lorna, on the other hand, chided herself for not following the directions carefully. A list of the criteria to be used for evaluation had been given to the students with the assignment sheet. She wrote:

> I was really disappointed today and I am ashamed to even say why. I do not imagine I did that well on my project. You see I totally forgot about the evaluation sheet we were to follow as a guideline. I don't understand how I could have done this but I did. . . . I missed some of the required criteria which would definitely bring down my grade.

The students were given the option of working alone or in groups of two or three. Initially, Bob reacted to this by commenting: "Group work--never!! Responsible for my own success or failure." He later reconsidered, joined with two others, and due to circumstances, ended up in a group of four. The experience was not with out frustrations and he finished with mixed feelings about the merits of group work. Jennifer, on the other hand, was enthusiastic about working with others. She wrote: "I have great partners for my math project--I am anticipating a really good experience." She attributed her satisfaction with the work done to the compatibility and efforts of the group in her assertion that "It helps to seek out serious students to work with."

Students who felt they had put considerable effort into their assignments suggested that they should have been worth more than 10 points. Some, like Jennifer, were quick to acknowledge that others had worked hard, too. She said: "I was impressed with the effort students were putting into their presentations." There were those, however, who were not impressed with projects which they perceived as having been "put together at the last minute."

The major source of dissatisfaction with the assignment was the peer evaluation which Bob referred to as "the pits." It was conducted during a seminar class and was organized on the same basis as the assignment: Those who worked alone evaluated alone, and those who worked in groups evaluated as a group. Each project received two evaluations. Criteria sheets used were the same ones which students had access to while preparing their assignments. The grade received was the mean score of the two evaluations. In cases where there was a large discrepancy, students could request an instructor evaluation.

There were two main objections to this procedure: inconsistent standards due to students not being qualified to evaluate, and unfairness which resulted from competition. One student described the situation as: "the blind leading the blind," and another commented: "I, myself, did not feel competent and many share my feeling." Jennifer concurred: "I feel somewhat uncomfortable in the presence of my classmates in a marking/evaluating capacity."

The feeling of unfairness was variably expressed in phrases such as: "being slighted by cruel peers," "students out to get each other," and "peers mark with selves in mind." Before it took place, Dianne seemed to feel positive about peer evaluation. She wrote: "I think the fellow students will base their decision on appearance and whether they would bring it into their classroom . . . I do think they will be fair with one another." After the evaluation, however, she expressed anger: "They tend to be rather subjective in their marking after comparing it to their own project. I found some of their statements unjustified or obviously it is apparent that they misunderstood." Many students did, however, attempt, attempt an honest evaluation. Jennifer wrote of her group's experience: "We assigned them a 16 and we did agonize a bit though because we wanted to be fair and objective. . . . I think many of us felt unworthy of marking each other's work." Reflecting on the situation at a later date, she suggested: "Perhaps students ought to have a lot more respect for the opinions of our classmates."

Helen felt inconvenienced by the necessity to bring her assignment back for instructor re-evaluation. She felt that, at that point in the term, she simply did not have the time. Other students voiced the same objection; they would have had to reassemble their projects, some of which were awkward to carry around, and find a suitable time to bring them in.

Unfortunately, none of the instructors were available on one of the days that was scheduled for peer evaluation because it coincided with a mathematics teachers' convention. This affected two seminar sections, and arrangements were made for a substitute to be present. A number of the students were distressed by this situation, interpreting it as "a lack of concern for our ideas and methods." They also felt that instructors should have been there "to consult with" and to monitor the competition.

Another disappointment with the evaluation was that there was not enough time for viewing assignments other than the ones evaluated. Jennifer regretted: "At the end of our presentation, we had to pack everything up and take it with us and nobody was ever going to look at it again!" Lorna suggested that more time should be allowed for students to take turns presenting their projects.

The assignment proved to be a negative experience for many students. Initially, the major concerns were interpreting and conforming to the given criteria. Most students felt that preparing the assignment was a valuable activity, and by evaluation day they appeared eager to display their projects.

A competitive atmosphere developed during peer evaluation, and the results left many discouraged and bitter. Some felt short-changed. They accused their classmates of being incompetent and underhanded, and the instructors of being indifferent. Generally, there was an appeal for instructor evaluation, more course credit for the work, and an opportunity to share projects.

Term Tests

Formal evaluation was conducted mainly through examinations: two 50-minute midterm tests, each with a value of 20 percent and a 90-minute final examination worth 30 percent. All examinations were composed of both multiple-choice and short-answer questions. Students reflected on the format and content of the term tests, how these conformed to their expectations, and how they felt about their results.

Before the first test, Jennifer wrote: "I am beginning to sort through the chapters again for next week's test." She later noted that she had done "okay." Looking back on her studying, she commented: "I learned a lot of information in studying that wasn't tested, but I'm not frustrated by that." Jennifer was satisfied with her mark and pleased because "The questions that I didn't do so well on I now understand."

Following the first test, but before grades were received, Bob wrote: "Well written--tested application of knowledge, not memorization." Though he seemed satisfied with the test, he was disappointed with himself, saying: I didn't do as well as I wanted, especially on the ice cream problems." Then, when his paper was returned, he expressed "anger" and "outrage" at the suggestion that his 68% was a minimal passing grade. He vented his frustration by writing: "I don't have any more time or energy to spend. Guilt feelings. Anger. What a lousy day!!!"

Dianne found that the multiple choice questions were "fairly straightforward," but that the others were not "a summation of what was emphasized in class." She wrote: "I thought the exam would follow the text more closely but it tended to overemphasize problem solving." This caused her some anxiety expressed as: "I felt awful after writing and some old math fears tended to creep up during the examination time." Reflecting on the same test, Lorna conveyed dismay: "I sure hope I did alright . . . I do know I made some careless errors." Helen was much more positive; she "enjoyed" the first test because she felt "everything was related."

Preparing for the second midterm test, Jennifer found the material "somewhat different from that which we were tested on last month." She referred to it as "more global" with fewer "facts to remember." She expressed some anxiety about this, but felt "well prepared" to write the test. After the test, she described the questions as "well written," and thought that, generally, people felt better about writing the test. Bob hesitantly agreed with this, saying: "I think I wrote a good exam, but I think I've sung that song before."

Dianne had some misgivings about this test, commenting: "You shouldn't give material that wasn't ever looked at in class." Both she and Jennifer made specific reference to a problem which seemed to confuse a number of students. One person complained: "Some questions were not in a form consistent with lectures or labs," accusing the instructors of "throwing curve balls." Situations like this intensify the need to know what is expected. Dianne made an appeal for more direction, asking: "For the final exam, would it be possible to tell the class where the emphasis is going to be in the readings? For the last exam, much of what we were required to read was never touched upon." A number of students felt that the test had put too much emphasis on mathematical content as opposed to teaching methodology.

Most students seemed to approve of the general format of the tests, but some admitted difficulty with particular aspects, such as time and types of questions. For example, Lorna said: "I feel that I understand more than what the exams show because I do have a problem in every case with the multiple choice, but that's another story." Jennifer also mentioned that other students had expressed frustration with multiple-choice questions.

When studying, students tended to anticipate what would be on the test. Expectations were based on what topics were emphasized in class, and the manner in which they were treated. They used the same criteria when assessing their performance and judging the fairness of the test. Usually, students felt that they were well prepared for the term tests, and often blamed poor results on the format or content.

General Evaluation

The main source of dissatisfaction with the course was the system for determining grades, but unfortunately, much of the anxiety was based on a misinterpretation of the grading process. The methods used were, in fact, consistent with university regulations and departmental policy.

For each test the raw scores were ranked, and students were given a "suggested" score on the nine-point system. The purpose of the latter score was to give students an indication of where they stood in the class with respect to that test; these scores had no absolute value. Before the final examination, a similar procedure was followed, using the total raw scores to date. Some students misread the intention, assumed that a bell curve was being imposed, and that a predetermined number of students would fail, regardless of their marks. This was not the case. While the mean score and distribution had some influence on the relative grades assigned, the proportion of students receiving any particular grade was not fixed. In fact, only one student failed the course.

The perceived problem was aggravated because, especially when dealing with large numbers of students, a bell-shaped curve usually does result when raw scores are rank-ordered. Such a curve, however, is formed by the scores; the scores are not made to conform to a predetermined curve.

Lorna enjoyed the course very much, claiming it was one of her better curriculum and instruction courses, but she was disappointed with the marking system. She felt that the standards were too high and that there should have been a given distribution criteria which would translate raw scores into nine-point grades. She explained: "That's why people are getting really upset . . . you don't really know exactly where you stand." She argued that students should be "judged on an individual basis"; their grades should not depend on "the way other people perform." Lorna also felt that a better explanation of the system being used might have helped because "I didn't fully understand exactly what you were using." She further reflected: "That's how I feel--and from hearing the talk and talking to other people, that's the problem." Unhappily, she concluded that the competitive system makes marks very important.

Bob had mixed feelings with regard to the evaluation problems. While he had been quite upset after the first test, and was not in favor of a competitive system, he had become, at most, accepting of the situation. He felt that the "fuss over marks" was "rather amusing." He wrote: "Of course a curve isn't fair--but who said it had to be? Life isn't fair most of the time. It's time the gripers grew up."

Overall, Dianne was happy with the course, but indicated that the marking "could be improved upon." Her attitude towards the system was similar to Bob's; in her words: "I don't think it's fair, however certainly acceptable." While she was somewhat dissatisfied herself, she felt that the most of the students had been "rather rude" in their protesting. She speculated: "I guess the major problem is that the marks will tend to be high and so one who knows 60% of the course material could very well get a very bad mark," and then added: "I hope I'm not one of those!"

Jennifer, herself, was not upset about the grading procedures and expressed disappointment with her classmates' behavior, saying: "I couldn't believe it!" To her, the situation had generated a "bandwagon" effect. She acknowledged the difficulties involved in evaluation by posing a question: "Will there ever be a means of evaluating the students and really doing it so that the marks totally represent the effort and the work and the involvement and the information retention and the new ideas?"

Most students began the term eager to learn how to teach mathematics, but as time passed, matters related to getting through the course often took precedence. Pressures of the compressed term and the class size soon began to cause dissatisfaction. The students tended to discuss the course in terms of its structure and requirements, focusing on the lecture and seminar components, and the assignment and exams. The major source of stress was evaluation procedures.

Feeling Prepared to Teach Mathematics

At the end of the course, comments such as: "I still don't know how to teach" and "Now I really feel that I can go out and teach math well" were voiced by students in ED CI 216. Though these two statements represented opposite viewpoints, they indicated that feeling prepared to teach was an important goal. What they needed to achieve this sense of preparedness differed among students. Some felt that they needed to learn more mathematics and improve their own skills, while others believed they had an adequate understanding of the content but wanted to know how to teach it.

Students came to the course with varied backgrounds. Some already had experience tutoring, giving private lessons, or helping their own children learn. While these people often felt they already knew how to teach, others felt like complete beginners. Some found the feeling of preparedness came, in part, from the joy of finally understanding mathematics or experiencing success with unfamiliar topics. Doing seminar activities with concrete materials gave them confidence that they would be able to help children learn. On these bases they monitored that which was presented to them and sought that which they felt was necessary.

Mathematics Background

There were a number of students whose background in mathematics had not favorably disposed them towards the subject, and who consequently were apprehensive about the course. This situation was not atypical; in fact, the textbook used for the course had a whole chapter devoted to the issue of mathematics anxiety. Such misgivings about mathematical competence were shared by Jennifer, Dianne, and Lorna.

Jennifer's doubts about her mathematical ability influenced her decision to participate in the study; she was optimistic that she would benefit from the personal interaction. Her "worst fear" when she entered the faculty of education was mathematics. She felt that she lacked content knowledge and worried that she would present unclear lessons to her students. She put off taking the required non-education mathematics course until her second year, but subsequently was enthusiastic about the course she chose. While the positive experience really helped to calm her insecurities, many remained when she began this course. In fact, she admitted: "I would have done anything to get out of it!" She did, however, decide to accept the course as inevitable, and make the best of it. Early in the term she wrote:

> I am beginning to read about methods and materials and various approaches to teaching--designed specifically for people like me. I now believe that if I read texts and apply myself to the material that I will improve and my students will benefit.

Her attitude remained positive, and towards the end of the term, she said: "Certainly I feel a lot better about math than I did at the beginning of the term. . . . It really turned out to be quite manageable."

On the first page of her journal, Dianne wrote: "I am the typical 'I'm terrible in math' student. Whether it was due to failures in elementary school or lack of studying later on in secondary school, I never did well." She was worried that her own mathematical inadequacies could affect the children she would teach. Reflecting on her own school experiences, she hoped to make it "different" for her own students, so that they would have the opportunity to "truly enjoy" mathematics. To Dianne, a positive attitude was essential. She asserted: "I think math is definitely a subject that you enjoy if you're having success and one that you don't enjoy if you're not having success." Early in the term, she expressed some disappointment that the course was not making her feel excited about teaching mathematics. The immediacy of this need seemed to be related to the impending practicum. She wrote: "I am getting nervous about thinking that I have to actually TEACH math. I don't know where to begin! . . . I wonder if the children will really learn under my guidance." Near the end of the course, she was feeling more confident, yet some uneasiness lingered. She said: "To be quite honest, I do feel better about it now because of this course, but I'm still scared about it."

Lorna felt that she could definitely relate to mathaphobia. During one of the early seminar sessions which dealt with problem solving she said: "An old familiar feeling come over me. This was not a good feeling and one that began in my late elementary school years." She claimed to have overcome many of her fears a few years before, when she took a course to upgrade her mathematics qualifications, giving much of the credit to a very sympathetic instructor. She acknowledged: "I guess the first step towards succeeding to some extent in math was just finally thinking to myself 'I can do math.'" She further noted the irony of the fact that she had worked in a bank for three years, using mathematics daily. "I guess," she explained, "in this sense math had more meaning--it just wasn't a series of computations and rules." Like Jennifer and Dianne, she was concerned about the children she would teach. She wrote: "I do not want to impose this handicap on my own students. It is only obvious that my own feelings will somehow surface while teaching math." Lorna enjoyed the classes, and her confidence increased throughout the term.

Helen was not overly anxious about mathematics, though it was not one of her favorite subjects. She said that she was good at "facts," but had difficulty with trigonometry, and quit taking it in grade 11. She attributed some of her problems to early circumstances. Her parents used methods different from those she learned in school, and this caused her some confusion. Having been out of school for a number of years, Helen felt that methods for teaching mathematics were improving, making learning more enjoyable. She even noticed a difference among her own children; the oldest one "learning by rules" and the younger ones "with more understanding."

Basically, Bob felt positive about teaching mathematics. He said: "I don't think I'll have any problem. I enjoy math myself." He did experience some difficulty with problem solving, but spent considerable time working in this area, and found great satisfaction when he was successful. He, too, recognized the importance of good attitudes, saying: "If the teacher has enthusiasm and warmth for the kids, you'll carry them along no matter what method he uses."

Similar accounts were given by others who expressed relief that their fears of mathematics had been alleviated. One student happily reported: "For me, this math course has been a very positive thing. . . . I have never been too keen on math and I feel I have been able to identify some key reasons." Another said: "I never liked math after grade nine and was very anxious about this course but came out of it feeling I will be a very competent math teacher." Recognizing the significance of eliminating negative feelings, one person wrote: "This class has relieved a good deal of my math anxiety and has shown me how important a good, positive attitude towards math is needed in the field." Accounts to the contrary which claimed that feelings of anxiety were not eased or actually increased were rare.

Many students in ED CI 216 suffered from mathematics anxiety, an affliction which was often traced back to elementary school days. These fears contributed to feelings of incompetency and self-doubts about being able to help children learn mathematics. Fortunately, most students managed to overcome their insecurities and anticipated teaching mathematics with increased confidence.

Goals and Expectations

What students wanted to learn in this course varied as they came with diverse mathematical qualifications, unique backgrounds, and, in many cases, ambivalent attitudes towards mathematics. Most of them, however, were critical of what was presented, basing judgment on personal needs. Those who were positive about the course often referred to its practicality. For example, one student wrote: "This was a useful course. It helped clear up many questions I had about teaching math"; and another commented: "I found this course one that I'll remember and use in my class." on the other hand, some expressed their dissatisfaction as: "I don't feel prepared to go out and teach math. I learned more math, not how to teach it!"; "I know no more than when I started"; and "I feel we have been let down and turned out into the cold."

Early in the course, Lorna wrote: "So far in the ED CI math course I feel quite comfortable. I want to know all I can about teaching math." She especially looked for practical applications of ideas. After one class she commented: "It enabled me to understand . . . how problems can be used in associations with our daily lives"; but on another occasion she was disappointed with a lack of realistic examples and concluded: "I guess . . . it is meant to be a guideline and not a practical sort of course."

Lorna liked the problem solving method of teaching computation and the emphasis on use of concrete materials. She expressed pleasure: "I particularly liked the last two lectures as it gave us more of an example approach in teaching computation." Being given situations and told how to go about handling them was to her, a suitable form of instruction. In her words: "Approaches to assist children in learning and understanding the math skills we must teach are what I would like to see more of." She admitted: "I would have probably tried to teach this using much the same method that I had been taught with."

Helen voiced similar thoughts; she had expected to be told to teach as she was taught. She felt better about the newer methods, explaining: "Math, it's interesting, it's relevant, it means something. When I was going to school, math meant nothing. . . . They gave you rules." In fact, relevance was a key word for Helen. Referring to her young daughter's experience, she said: "They're given problems to work out, and problems that are relevant to them." She was also impressed with the hands-on activity approach to learning, and this was evident in her reaction: "You have them moving around, experimenting, discovering, all of those things that I didn't know you could do. I think that's neat!" She recognized the responsibility of preparation, asserting: "Everything can be interesting if you spend the time to look for different ways of teaching it." Making connections became important for Helen, as she reflected: "Because of the broad range of skills and processes involved in understanding the concepts of mathematics, it would appear to me that integration of other subjects would be quite easy."

Helen was disappointed with the non-education mathematics course she had taken. She enjoyed it but did not think it would help her as a teacher. She explained: "I just don't think that [MATH] 261 was relevant, I like to have ideas." This opinion, she believed, was shared by other students. By the end of this curriculum course, Helen was happily anticipating her practicum and the possibility of teaching mathematics. She enthused: "I'm dying to try out some of these math concepts!"

While Dianne, too, was looking forward to her student teaching assignment, she was somewhat more apprehensive. She had started the term with "quite a general objective," which was "to bring" and "to teach" the different subjects to children. Recognizing different learning styles, she wrote: "One thing I am concerned about is the necessity for INDIVIDUAL work with the children." Personally, she felt the need to know more mathematics content herself, finding it difficult to learn how to teach and still get some of the subject matter in such a short time. She said: "Overall, the course was good and I did learn," and then added, "hopefully, I'll be able to take more math courses in the future."

As to practical application of the course, she reflected: "You can get some wonderful ideas from these courses, but I think in the end you have to take your own teaching methods into the class." Like Helen, Dianne recognized great opportunities for integration of mathematics with other subject areas. She explained: "I'm definitely seeing how important integration is, and how really simple it is. . . . Math, I think has often been seen as math, as a separate subject."

Jennifer also saw the significance of integration. While preparing for mathematics and science tests at the same time, she wrote: "I find it so interesting where the two subjects begin to meet in terms of concept development, teaching methods, and teaching aids." She noted that skills, objectives, and teaching-learning sequences are common to different areas. Her main concerns as a future teacher were knowing her students, reducing anxiety, and making learning interesting. "Variety is the spice of learning," she wrote, after reflecting on the responsibility of planning and lesson presentation. She was concerned about meeting individual differences, stating: "Students cannot all be expected to learn and understand all the material presented as the age group and intellectual development will surely vary among a group of 25."

Jennifer was excited about learning the left-to-right method of subtraction. As it was for Helen and Lorna, the approach was a departure from what she had expected, and she found it very meaningful.

She often related what was being done in class to her experience of helping her younger sister with mathematics. Speculating that perhaps her sister had not "attached enough meaning to the processes behind the facts," she hoped to offer her students more meaningful learning. She was "really looking forward" to her upcoming practicum and was "eager to try out the ideas" that she had learned in this course.

Bob said that he mainly wanted to learn "the nuts and bolts" of teaching mathematics. He found many of the ideas presented in class to be interesting, but was ever skeptical of their practicality. He demonstrated open-mindedness in comments like: "Great new idea. Makes sense," or "New thought for me. Interesting!"; and sometimes requested further references. Often looking for rationale or clarification, he asked questions like: "Why! Unclear!" and What is the point?" After a lecture on a new approach to counting and numeration, he asked: "What grade do you introduce this system?" It was often in the light of having taught his own four children to read, and having observed them learning at home, that Bob monitored the course content. Reacting to reference made in class to a common error made by children when learning to count, he wrote: "My kids never had a problem." Generally, he felt quite confident about the prospect of teaching, but shared Jennifer's and Dianne's concern for being prepared to deal with individual differences.

As well as expressing approval or dissatisfaction about what they did learn, some students suggested that the course was lacking in certain areas; that is, all expectations were not met. The chief concerns were absence of information on diagnosis and remediation of mathematical learning problems, and the need to spend time on lesson planning.

When they began the course, students did not necessarily know, in an explicit sense, just what they expected to learn. However, most of them seemed to, at least tacitly, have some basis for appraisal of the course content. This intuitive judgment was influenced by the unique mathematical knowledge, personal experience, and attitudes which they brought to this situation. As the term progressed, their goals usually became more specific, and the extent to which they were realized had a bearing upon satisfaction with the course.

Textbook

If there was one aspect of the course which received nearly unanimous approval, it would be the textbook. Most students found it to be well written, clearly organized, and readable. Dianne said: "The test is excellent, well thought out, and conducive to studying." Jennifer agreed with this, writing: "The text is so easy to read and reread. . . . The writing style seems to flow nicely." Many remarked on its practicality. Lorna noted: "The text has a lot of really good ideas," and "it will be one that I will keep as a reference." The one drawback mentioned was that it was not a Canadian publication. This was not a unique problem, as Jennifer stated: "It's quite surprising how American all my textbooks are, a little discouraging in fact."

Lectures

Reaction to the quality and usefulness of the lectures was diverse. On one hand, they were credited with being "informative," "interesting," and "practical"; yet on the other hand, they were denounced as being "boring," "disorganized," and "Mickey Mouse."

Those who were pleased with the lectures usually felt that they contributed to their preparedness to teach mathematics. For example, one student noted: "I found the material presented in lectures very informative and useful as a future teacher"; and another wrote: "The examples given in class were good, applicable for various grade levels, and fun!" Some students enjoyed the lectures because they found them interesting. One commented: "I thought the lectures were great, informative, and exciting." Following a lecture which she found stimulating, Lorna wrote: "There were many things brought out of the lecture that I had not really considered before."

Dissatisfaction with the lectures often stemmed from the feeling that they were useless and uninformative. One student complained: "Content of the lectures was disorganized and difficult to process. I found it difficult to relate what was being talked about to any practical experience in the classroom." Offering constructive criticism, another wrote: "I would like to have seen more in the lectures on how to help teach math, how to help the students understand certain concepts."

The most frequent criticism of the lectures was that they followed the textbook too closely. Typical of such comments is: "Many of the lectures were almost exactly the same as the textbook. It seemed that the lectures did not reinforce the textbook but were a repetition of it." In some cases the quality of the lectures was perceived to be inconsistent, as is evident in the statement: "Some of the lectures were quite good and they did promote an understanding of what was to be taught, but many of the lectures were a total waste of time." A couple of students who were displeased with the lectures were at a loss to offer suggestions. In fact, they doubted that they could be improved, remarking: "But math isn't always the most stimulating topic," and "I don't think the content could be more interesting."

Both positive and negative reactions to the lectures were received. Students tended to evaluate these classes on the basis of whether their needs for practicality, stimulation, and variety were met.

Seminars

As with the lectures, students' evaluations of the seminars reflected both satisfaction and discontentment. Most found them worthwhile and emphasized the opportunity to see and use materials, and to share ideas with their classmates. Negative comments usually were voiced by students who focused on putting in time and who saw little value in the activities.

Enthusiasm for the labs was expressed as: "I loved the seminar and looked forward to it each week." Throughout the course, students mentioned the importance of becoming familiar with concrete aids and other learning resources. One student remarked: "The labs were especially excellent, I think that actually using the materials that the kids would be using was an excellent idea, and very helpful." Frequent observations stressed the wide selection of manipulatives used in the seminars. Jennifer noted: "There are a tremendous variety of aids to offer students in the classroom," and suggested: "A variety of colors, sizes, and shapes should be available to ensure there are models which students will be able to relate to." The potential stimulating effects of these materials was also recognized. Helen was especially impressed with some of the geometry aids, writing: "Interesting, motivating manipulatives. Loved the velcro figures!" The students realized that discretion was required on the part of the teacher when selecting materials. After one seminar Lorna noted: "This time we were able to pinpoint some disadvantages in the devices that were used. These would be things I would consider when teaching." Another student stated: "It is important for a teacher to consider the usefulness of various types of concrete materials." Specifically with regard to numeration, Bob wrote: "The abacus is the most practical manipulative material for classroom use."

Early in the term, Dianne wrote: "The labs so far have been fairly good where we are able to actually work with the materials and with our fellow students." Many other students enjoyed the increased interaction with their peers, which was facilitated by the small groups of five or six students seated at each table. Lorna wrote that she and others found this arrangement beneficial: "Working in a group was definitely encouraging and it brought out many ideas . . . I have spoken to other classmates . . . they found the group work and sharing of ideas to be of great assistance." Another commented: "When everyone chips in their idea of what we are supposed to be doing it becomes clear to me what is the objective of the various activities." Having found peer discussions worthwhile himself, Bob felt that children could benefit too, noting: "Group work is an ideal setting for optimal student achievement."

Recognition of the need to understand how children learn and to be able to guide them was often noted in the labs. Lorna reflected: "The activities really enabled me to see the challenges through the eyes of a child." Similarly, Helen wrote: "It was much easier to see relationships using the manipulative objects." Relating a lab experience to future work with children, Dianne said: We really didn't have time . . . to really sit down and think about it because we were sort of rushing through, but with a child, they would have more time."

Most students were impressed with the activity approach to learning mathematics. One student commented: "Hands-on activities are valuable in that they hold attention and provide visual aid," and another summed it up: "Learning by doing seems to be the key." The teacher's role was not disregarded. Jennifer wrote that "guided discovery" and "purposeful specific objectives" were important"; and Bob warned: "You must not allow kids to get frustrated by leaving them too long at any one activity." He further noted: "You have to give kids lots of time to fool around with shapes."

It was while doing the seminar activities that many students identified their own needs as future teachers. After examining the curriculum guide, Bob wrote: "I must become proficient in all 5 strands." Later, when he had completed the calculator activities, he realized: "The teacher must know the calculator cold." Dianne thought that she could teach children how to use the calculator, but said: "I don't really know how to use it so that it will really help the students." Consequently, she requested further references on the topic.

Personal shortcomings were often perceived during the labs. For Helen, a problem solving session led her to reveal: "I found I was very limited in my capacity to figure out problems." Similarly, Lorna wrote: "I realized how out of practice I was when working with problems. My own experience in problems needs refreshing." Sometimes difficulties were unexpected, as Helen indicated in the measurement seminar. She remarked: "I was surprised by the measurements that I could not estimate." On another occasion, the opposite situation occurred for Jennifer, who happily reported: "The ease with which I was able to complete computations was a wonderful break."

Translating theory into practice was an important goal and the seminars provided a chance to at least simulate some classroom experiences. Jennifer wrote:

> I think it was great that we had an opportunity to handle those types of learning aids that we have been reading about, hearing about et cetera. Every now and then I begin to feel like I'm getting somewhere in my 'training' to be a teacher. Today was one of those days. In my lab I felt good because I *knew* the theoretical functions and to try them out somehow proved to me that they are indeed legitimate and valuable.

Those who put down the seminars seemed to devalue the very things that were most meaningful to those who appreciated these sessions. For example, instead of viewing the labs as an occasion for group work and sharing of ideas, they described them as "visiting sessions." They indicated little confidence in peers, as one student asserted: "The seminars were a waste of time--you [the instructors] could have spent more time explaining the activities rather than have us sit around a table for 50 minutes (It was a fun gossip session)."

Another aspect which some students seemed not to appreciate was that the activities were meant to be done with children in mind. One person wrote:

> The seminars were a joke. We could be given the handouts and as we had nothing more than manipulative objects, we could have 'got the idea' without spending an hour of our time. . . . Some of the seminar concepts were so simple that it insulted our time and background.

Reaction to the seminars was mixed, though the dissenters were in the minority. Those who valued the labs most appreciated the group discussion and chance to work with children's learning aids, and those who were dissatisfied found little purpose in either.

Feeling prepared to teach was a major goal of the students in ED CI 216, but what was needed to achieve it was individually perceived. Personal expectations were influenced by mathematical competency and background experiences. Objectives included knowing the content in the curriculum, improving their own skills in mathematics, understanding how children learn, and acquiring practical ways to teach it and make it interesting. Continually evaluating the course on the basis of how well it met their needs, students reacted to and reflected on the course content as it was presented through lectures and seminar activities.

Looking for Models

Models of teaching are always presented by teachers, whether or not this is explicitly intended on the part of the teachers or explicitly perceived on the part of the students. Those enrolled in ED CI 216 all had had experiences with teachers at the elementary, high school and university levels. It was to these teachers, along with the three instructors of this course, that the students looked when forming their own self-images as future teachers. On the basis of their perceptions, they aspired to emulate those qualities and behaviors which they admired and eschew those traits and practices which they found objectionable.

Former Models

Dianne recognized the influence of her early school years on her perception of good teaching as she reflected:

> Now that I look back and know a little more about education, it was a really good school, very progressive, and I enjoyed those years very much . . . my teachers were very encouraging . . . my favorite teachers now are still the ones from [that school].

She also contrasted her memories of two high school mathematics teachers; one who screamed all the time, and in whose class she did poorly; and her favorite mathematics teacher, whose encouragement had made the class enjoyable.

Helen did not identify specific teachers from her own school days, but she spoke about some of the teachers that her own children had in elementary school. Impressed with their outlook and methods, she was encouraged to pursue a career in teaching. She said: "After seeing my children's teachers and talking to them, it didn't look as difficult as I thought it would be." From her daughter's experience she recognized that teachers' roles are not identical at all levels. Of junior high teachers, she noted: "The teachers tend to treat that age group a little bit differently than they would maybe in the grade three or four; there's still affection there because they're small, but these are young adults."

Some of Lorna's fonder memories of mathematics teachers were those of the instructor she had when upgrading her mathematics background. She was influenced by his patience and positive attitude. Jennifer remarked about similar qualities in the professor from whom she had taken her non-education mathematics course.

Both Bob and Helen spoke well of the interaction they had experienced the previous year and which they missed in ED CI 216 due to the large number of students. Bob said: "I felt a lot closer to the teachers in the [9-credit CI course] than I do now." Helen felt that the classes should provide a model for professional relationships, regretting: "This institution doesn't prepare you to interact with people."

The impact of former teaching models often is not recognized until the experiences are deliberately recalled or brought to memory by present needs. While the recollections may be incomplete or incongruent with the original experiences, what is remembered is what influences perceptions.

Developing a Personal Model

Bob was quite explicit about looking for models of teaching. He ascertained: "One of the things I look for other than course content is the skill of the teacher." In fact, he indicated that he took this for granted, stating: "I expect, especially in the faculty of education, that if a professor is going to stand up there, they should have a skill." Referring to a professor in another course, he further explained: "He had a huge class, but he had a real skill; and I think teaching is an art form and that's one of the reasons why I like to look at the professors I have."

As part of his effort to search for models, Bob kept a running commentary in his journal during lectures. Before a class, early in the term he wondered: "Is lecture format an effective way to teach? What will my teaching method be like--to lecture or to let kids discover it themselves--or a mixture of both?" He followed this up in a later entry where he reflected: "Will kids learn better if they're having fun? Rhymes, music? Unlikely to resolve until I get a class of my own!!"

As a student, Bob preferred to have ideas presented with a clear purpose and in a straightforward fashion. When he was unclear about what was being said, he would react by jotting: "What is the point?", and in one instance he added: "As a teacher, I shouldn't beat around the bush." Pondering this generally, he wrote: "Why cannot . . .any teacher . . . tell the students at the onset of the lesson what it is that is to be taught," and then reflected: "I think that my students will appreciate the 'journey' through the 'land' of numbers if they know the lay of the land before they start."

When one question was asked in class, he noted: "As a teacher, I should rephrase student's question. Since not all students will have heard student question, therefore teacher answer is meaningless." Another time, he remarked: "[The instructor's] efforts to involve the class via questions is commendable."

He monitored the lectures, writing comments such as: "Too fast," "Excellent pace," "Speak clearly," and "Speak louder." Responding to what he described as an "undercurrent of conversation" and "students dictating when lesson ends by closing books," he saw these occurrences as evidence that the lecturers were not in control of the situations. He observed methods of presentation such as overhead projector use, noting: "Quit reading the overheads to us--we all know how to read!!!", and "Can't read overhead from side of room." On another occasion, when an instructor placed a message on the overhead to get the class' attention, he wrote: "Not a bad idea for my students."

Lorna was concerned about what she perceived as discrepancies between how she was being told to teach and how she was being taught. Early in the term she wrote:

> Overall I was feeling that somehow in this course there seems to be a contradiction in what view we should have of mathematics (or develop in our students) and the method in which we as future teachers are presently instructed.

She thought the intended message was to put emphasis on the learner and to present math in relation to daily life rather than a "structured body of knowledge" or "disconnected collection of rules and facts;" yet felt that she was being "given" abstract rules, guidelines, and applications which were too far removed from the practical. These impressions were influenced by her admitted search for practicality, and later in the term she began to feel better about meeting this goal.

With regard to evaluation procedures, however, Lorna again reacted on the basis of how it provided a poor example for classroom application. She was very disappointed with the notion of grading people on a comparative basis. "When I go out in the classroom, I don't feel I'd ever want to use that sort of distribution," she emphasized, asserting her belief in individual assessment. Other students were quite outspoken on this same issue. One wrote:

> In all CI's we are taught how to evaluate children so as not to hurt progress or self esteem. . . . I am so sick of being told to do one thing and being taught myself the way I am never supposed to teach! . . . The contradictions and the hypocrisy is enough to disillusion even the most dedicated teacher.

The element of competition in the evaluation procedures provoked reaction, expressed as: "If one is to expect the spirit of cooperation to extend to the schools, it really should begin at the university. Shouldn't it?"

Other areas of contradiction were noted. One student stated:

> I found that in the lectures when a question was asked they were never answered sufficiently, it was like what we [the instructors] said is the way you do it and there was no justification for what we were learning and this was the exact opposite of the method we were being taught to use in our teaching of children. Practice what you preach!

The absence of the instructors on one assignment evaluation day offended some students, as is evidenced in the comment:

> To have us do an assignment and not have the decency to even show [illegible] ideas is a poor example of what teachers are

> really supposed to be. For us as future teachers to follow such an example would be the biggest disgrace of our profession-- is this the way we are supposed to treat the children in the classroom.

Jennifer reacted much more favorably to the modeling which she perceived in this course. She looked for purpose in how things were presented. After one lecture, she wrote: "I think [the instructor] lays it on a bit heavy with the examples"; and then further reflected: "Perhaps [the instructor] is modeling a more concrete approach to teaching?" Near the end of the course, she indicated her appreciation of the approach used. For her, it emphasized that ideas and attitudes were what was most important.

Seminar experiences led many students to anticipate their roles and self-images as teachers. Affective considerations were very prominent. Written reflections are exemplified by the following: "I want math to be fun for my students and part of that is being excited myself"; "I think I will have to begin to enjoy arithmetic as a teacher in order that I do not create frustration"; and "Teachers should also show that they themselves sometimes make mistakes."

The students often took for granted that the instructors should provide good models of teaching. Some looked back at previous teachers, usually remembering those they most admired or least appreciated. They looked for models for lesson presentation, interaction with children and colleagues, and methods of managing their classrooms. Those things which seemed contradictory caused the most consternation, especially methods used for evaluation.

Student Reflections

Throughout the course, the five main participants proved to be steady and interested students; and towards the end of the term they were, like most of their classmates, anticipating the upcoming practicum with mixed emotions. The stress of facing a battery of final examinations was punctuated with the combined excitement and apprehension of entering the classroom as student teachers.

Dianne, who had been assigned to a grade one class in a city school, admitted: "I'm really nervous about going out to student-teach." When she found out that her cooperating teacher's assignment was 20% music she was pleased, explaining: "Which I'm happy about because I'm thinking of minoring in music." Dianne had begun the course with misgivings about her ability to learn and teach mathematics. While she was still concerned that mathematics content was "one of the weakest points now that I have," she said: "I've gotten quite a lot out of this course; in fact, I think that I could now go into a classroom." She added: "To be quite honest I do feel better about it now because of this course, but I'm still scared about it." One of her concerns was how much freedom she would have to take her own choice of materials into the classroom to teach mathematics. Over the term she had gained some confidence, and had recognized the need to relate mathematics to other subject areas, and was beginning to see how that could be accomplished. She had also grown in her sensitivity to identify her own needs as a future teacher of mathematics and to set personal goals.

Having been assigned to a cooperating teacher who taught grades four to six, and who also had a 20% music assignment, Jennifer commented: "That [music] was my worst CI so I know it is a good thing. I need a lot of improvement in this area." In a more general sense she said: "I'm feeling very excited about our practicums," elaborating: "I am eager to try out the ideas on my students during my practicum and I am beginning to feel worthy of student teaching status. At the beginning of the term I felt totally unprepared but this term has pulled a lot of loose ends together." Jennifer had been very receptive to new approaches to teaching mathematics and was most concerned with making it meaningful to her future students. She was inspired by one instructor's approach, explaining:

> Numbers don't seem to really matter to him. It seems to be more like the ideas and the attitudes and all that sort of thing that surround math . . . that just fostering a really positive attitude towards math is what's most important.

Helen was very pleased to be assigned to a grade five class at a school near her home in a nearby community. While she eventually hoped to teach primary school, she looked forward to getting into a classroom. She was enthusiastic about the activity approach to learning mathematics, but felt that there had not been enough time in the short term to "take in" all the ideas in the course. She regretted: "We're going to go out student teaching--sure we'll get a chance to quickly use what we've learned--and then we're going to be back here for another year, and how much of that is going to go by the wayside?" Helen was determined to make mathematics learning relevant for the children she would teach. She believed that children should be given problems that were meaningful to them, emphasizing: "That's what we have to realize." By the end of the course, she was convinced that all children could and should be successful learners of mathematics. She asserted: "I want my kids [students] to go through my class feeling good about themselves, and that they can do it; maybe they're not ready, maybe they have problems, but they can do it!"

When examinations were finished, Lorna was scheduled to return to her home town for her first major student teaching experience and to spend the Christmas holidays which would follow. Her assignment was a grade three classroom. She wrote: "I am looking forward to this practicum and am definitely taking my math text with me for any ideas and procedures." Practicality had been important to her all through the term, and in this respect the course satisfied her expectations. She said: "There's a lot of useful things like the labs, things that will be used . . . things in this course can be applied." While Lorna was pleased with what she had learned in the course, her dissatisfaction with the evaluation system remained. She regretted: "I am still disappointed over the marking system." She felt that she had worked hard, yet had been judged on the way other students had performed. Lorna grew to appreciate the significance of mathematics in everyday life and the need to think about how children acquire meaning. These views and her willingness to explore new ideas about teaching helped her to gain confidence in her ability to help children learn mathematics.

Bob's practicum assignment was a grade five class in the adjacent county where he lived. While he felt confident about his ability to teach, he expressed concern: "From what I understand, a hostile or unsympathetic cooperating teacher can really hurt your career." While Bob usually had been open to new ideas, he was not quick to accept them, probably due to basic beliefs which he held. He felt that children were capable of learning more mathematics than generally is expected in the school system, yet seemed to hold traditional views about teachers being in control of lessons. He expressed a sincere desire to accommodate individual differences among children. He said: "I'm a little concerned what I'm going to do when I get into a class situation and when I have . . . a number of students at different levels, and I'm really not sure how I'm going to tackle that." One of the most important things that Bob took to the classroom was his respect for learning. "Children love to learn and it's a joyous process for them," he said, hoping to nurture this attitude in his future students.

As did all the students in ED CI 216, these five people finished the course as they had begun, as individuals. Their personal experiences were intertwined, and shared perceptions emerged as patterns which were described thematically; yet each one remained unique, and would take a singular perspective into the classroom.

Researcher Interpretations

Learning and Control

The three themes; Getting Through the Course, Feeling Prepared to Teach Mathematics, and Looking for Models, are based on goals which students had for themselves while experiencing ED CI 216. Fundamental to all these themes was the process of learning and the attendant function of control. They all had been life-long learners through both informal and formal experiences. Many of them had been teachers, giving private lessons or helping their own children, and were in the process of formally preparing to become certified teachers. The significance of their past experience is that it was the basis for their preconceived notions, both implicit and explicit, about learning and teaching. In turn, these beliefs influenced how they interpreted their experience in the course. In light of their position, the students seemed to focus on themselves alternately as students or future teachers. When the student perspective dominated, the concern with getting through the course emerged, and when the future teacher perspective dominated, the concern was with feeling prepared to teach. Throughout the course they also were looking for models, finding examples in how they themselves were taught, and in the models they were encouraged to follow. All the students in the course learned. The three themes addressed this learning from the students' point of view; what they wanted and expected to learn, and the extent to which their goals were accomplished.

In this section, I will discuss the students' learning from my perspective as one of their instructors, and with respect to holistic conceptions of learning. In a short course like ED CI 216, true change in the holistic sense would not likely occur; however, there existed opportunities for growth towards such learning. Learning in the cognitive sense is not being dismissed. The students, in fact, processed a good deal of information during the course. How they perceived this information, however, reflected their holistic world views.

Of the three major goals discussed, perhaps the one most students, ideally, would have liked to give precedence was Feeling Prepared to Teach; and they approached this from the how-to perspective of looking for successful methodology. This stance suggested the belief, albeit implicit, that there were correct solutions "out there," that is, outside of themselves. This further implies control: if there were answers to be found and learned, an authoritative source must have existed.

Implicit Control

I was not surprised that many students came to this course with restricted views of learning. They had spent many years in educational institutions which espoused control. They had been told what to do, what to read, what to write, what facts to learn, and were evaluated on the basis of how well they achieved those goals--the institutions' goals. Learning in this sense was taken for granted, in fact, sought, because it had the security of familiarity.

For example, early in the course, the students were given an opportunity to become familiar with the Alberta Elementary Mathematics Curriculum Guide and some of the recommended textbooks. The purpose of this exercise was to provide an overview of the goals, views, and topics across the curriculum. Many students were impressed by the structure and prescriptive nature of the guide. Lorna noted: "The methods of instruction are a clear set pattern to follow." Another student expressed similar thoughts with even more certainty: "It explains exactly what is expected of teachers in each grade level." Teacher responsibility was addressed in the comment: "Teaching math in elementary grades covers a great deal. I need to pay attention to the curriculum guide and make sure that I cover all possible areas and the children reach goals stated." Such rigid guidelines were often viewed as necessary. Restrictiveness of the curriculum was assumed by a student who wrote: "[A teacher] must not deviate from the prescribed unit boundaries as it would infringe on next grade." One student spoke of the importance of "keeping the curriculum," and another expressed the significance as: "Supervisors and principals would have ~~a~~ more difficult time in assessing a teacher's competence if there was no curriculum guide." While the lack of flexibility was frequently noted, it was generally viewed as an advantage. Bob wrote: "Highly structured curriculum content ensures some degree of success as a teacher. The system allows LITTLE or NO flexibility as to what the teacher can teach." For new teachers especially this was seen to be a boon, as expressed in the observation: "Since very definite goals and procedures are outlined grade by grade some of the 'where do I begin' aspect will automatically be eliminated." While some students recognized the guide as a "framework," a "bare bones outline," or a "walking stick," a few took extreme positions as evidenced by the statement: "The guide is a Bible in which the students of all schools will develop at the same rate as well as being taught basically the same subject matter."

Implicit acceptance of customs can also lead to confusing the means with the end. To illustrate: when students were exposed to an alternative subtraction algorithm which worked from left to right, some were delighted and surprised that there actually was another method, yet some were unable to see its purpose. One student wrote: "Left to right is no good. Students then have to readjust to the right to left method. Why bother?" The power of tradition is evident in the statement: "I will never teach students a left to right method of addition, etc. Right to left has been taught and learnt for years and been successful." Consequences of deviations were pointed out by a student who warned: "I feel that these ways are good to use but if I teach a different way than what the teacher ahead is going to do, the child will become so confused." Another student was hesitant to break with custom, save for special circumstances: "I do not approve of left to right method except in an extreme case where the child cannot comprehend right-left." Even Jennifer, who was quite enthusiastic about the new algorithm, was not quite able to let go completely, and compromised, writing: "Always be open to a variety of interpretations and methods. Standard form is important and should be taught but creative problem solving has inherent learning and teaching qualities."

Exposure to calculators led to a similar dilemma of receptiveness to, and denial of, fresh ideas. Citing a common objection to calculator use in elementary school, one student cautioned: "I can see children getting so used to the calculator that their computational skills decrease." In contrast, Lorna asserted: "I can definitely see how they would be of great benefit and there is a great need to clear the myth about them causing interference in learning computation."

Breaking Set

The difficulty of changing life-long practices, which can become almost inseparable from beliefs, was addressed by the students. Problem solving, a topic considered early in the term, was an eye-opener for many. As one student observed: "There is often more than one way to figure out a problem but it is difficult to use more ways after your mind is stuck on one method." Recognizing that habits can be imposed by others and set in time, another regretted: ". . . that I have been conditioned to see problems only one or two ways and that this makes it difficult to be more divergent in approach. This is a problem in the school system." Other students traced their beliefs about mathematics to their elementary school days. Helen said: "When I grew up, only the smart kids could do math"; and another admitted: "I thought math was a trick system in elementary school." The effects of early experience were expressed by Dianne: "People tend to hold a 'grudge' against math before ever entering [lectures] due to the nature of the subject and how it's been taught in the past." A more far-reaching and potentially harmful consequence of customary methods was pointed out by a student who wrote:

> I am going to have trouble teaching the 'why' of mathematics. I learned by memorization of the rules of the algorithm, and I find myself saying that I would correct these problems by telling the students the rules and having them memorize them. I will have to try very hard to avoid this temptation.

Similarly, Lorna conceded: "I would have probably tried to teach [computation] using much the same method that I had been taught with."

When learning is structured for the learner, the product precludes the process. The lab sheet which accompanied the curriculum guide analyses emphasized fact-finding. The intention was that the students would survey and discuss all parts of the guide. When the pattern of questions was broken, this caused some discomfort. One student observed: "#7 on the worksheet was confusing after having all the answers from the curriculum guide before." Expressing similar feelings, another wrote: "I feel frustrated with questions that are open-ended. Structured questions are easier for me to understand where there is a direct 'formula' to work with." A possible effect of such structure was identified by a student: "I think perhaps the seminar would have been more successful if worksheet was not used. I found our group was more concerned with 'finding' the right answers than understanding what is going on."

In order to alter beliefs, one not only has to be willing to break set, but rationale for change sometimes is sought. For Helen, this was the case with an alternative method of multiplication she had learned in her non-education mathematics course. When she saw this method in the textbook for ED CI 216, she realized that she had forgotten how to do it. She surmised: "I was so conditioned to doing it the regular way" and had found the alternative method to be "very long and drawn out." Furthermore, she saw little value in learning it. On another occasion, one student gained appreciation of purpose for changing a viewpoint, writing: "I used to think that using calculators in math is sort of cheating. I now realize that math involves problem solving and calculators enhance problem solving." Most importantly, openness to new ways of thinking is self-motivating. This was suggested by Jennifer's enthusiasm: "This left-right approach is incredible and I really understand it! . . . I'm getting very excited about the ideas in this class. It really is a departure from the 'math' I expected to be working on."

Risk

Opening oneself to alternative ways of thinking involves risk. Those students who believed that mathematics was a rigid system or who recalled unhappy memories of failure, initially were hesitant to be creative when solving problems. The possibility of embarrassment was recognized and avoided by Bob when volunteers were asked to display their problem solutions on the board. He had figured out two ways, but admitted: "I didn't want to embarrass myself."

Less imposition of formal structure allows learners to be more flexible. One student wrote: "Children are better risk-takers than adults. They are less inhibited (not afraid to make mistakes). There is a greater openness of mind." Importance of lessening the apprehension was noted: "The child has to feel it's not bad to make mistakes and look at resolving the problem using a different approach." The teacher's role was also indicated by a student who wrote: "As a teacher I will have to give children practice in all approaches, and allow children to do this free of right and wrong answers."

Another kind of risk is that of personally losing the security of old ways. Bob addressed this in his journal, writing: "Self-examination can be very disturbing and a little frightening."

Time and Continuity

Given that a person is willing to take the risk of changing beliefs and, in fact, is making strides towards acceptance of new ideas, the learning process is neither abrupt nor isolated. With respect to taking an open-ended or creative approach to helping children learn methods of computation, Dianne wrote:

> This new way of problem solving is very interesting. I think however that what we're getting in lectures is not quite enough to change our whole method of computation, to feel comfortable enough with that in order to teach it.

Similarly, Lorna reflected: "I am not saying I have fully grasped what is involved [in this new approach to computation]," and later added, "I would like to get a better grasp."

Jennifer, Helen, and Dianne all observed the need for making connections when teaching and the ease with which they thought integration of subject areas could be attempted. Their comprehension was only beginning, however, as Dianne remarked: "Like I just have started to sort of understand it--you know, how easy it can be." The significance of this continuous aspect of learning was applied to children by a student who said: "Math is an accumulative process which is good. Children don't start learning but continue learning when school is in or out."

That true learning cannot be rushed was believed by the instructors of ED CI 216. The purpose of the lab summary sheets was for the students to reflect on what was most significant to them during the seminar and to provide food for thought. In the tradition of questions and answers, some students were frustrated, thinking that they were expected to identify profound new understandings. This feeling was expressed by one student: "I think more time and experience are needed to achieve a major insight."

Collaborative Learning

Many students began the course thinking that the processes and products of learning should be the same for all children, and that children should do this learning independently. Somewhat ironically, they discovered through the seminar activities that much learning can be cooperative and that the processes and products can be unique.

Lorna and other students often remarked on the benefits of group work. For students who were insecure about mathematics, it was helpful. As one student noted: "Student involvement and discussion is an aid to learning; it is easier with help and available information." Cooperative activities led to recognition and acceptance of other peoples' ways of thinking and provided an opportunity to broaden personal perspectives. This was appreciated by students who wrote: "The members of my group had different ways of approaching problems.

One person preferred to use a formula approach--I found I preferred a more concrete visual approach"; and "It helped in solving these problems to discuss how I was thinking with others. Talking over the problem allowed me to see others' way of solving."

Openness does not mean easy acceptance of one's own or others' new ideas; and this was pointed out by a student who remarked: "When working in groups, it sometimes happens that there are disagreements. . . . This gives the opportunity for those who disagree to have to back up their view." Learning can occur in groups, but what is accepted is personal. Dianne reflected on learning through coursework, and concluded that eventually one's own ideas are what have to be taken into the classroom.

Individuality

The uniqueness of individuals was succinctly interpreted by one student who wrote: "All people are different and think and learn in different ways." Following the realization that, as adults, they had very different ways of thinking, the students recognized the need for sensitivity to the individuality of children. One student noted: "Every child is an individual who will learn most efficiently with a method most comfortable to them."

Focus is often put on what a child is doing wrong, and for some children this means seldom feeling positive about their own work. Recognition of individual worth was reflected in the comment: "Although children have problems, there are *good* things everyone is doing." While affective considerations are of prime importance, appropriate learning materials are also necessary. Jennifer wrote: "A variety of colors, sizes and shapes should be available to ensure there are models which students will be able to relate to." She also emphasized that the learning aids "needn't be used exclusively for slower students or specific activities but also as a means of personal discovery."

Because the process of learning is individual, the context in which it occurs should be personally meaningful. This was asserted by a student who wrote: "Students will be more motivated to find answers (and learn more) if the situations asked deal with real life situations." Another agreed: "If a problem is *significant* to a person's life, they will want to figure it out." Lorna recognized this for herself, in retrospect, when she realized that she had used mathematics very naturally in her job at the bank because it had had "more meaning." Consequently, she felt this was very important for children. Commenting on the many materials available for learning numeration, she said: "The visual and concrete representations of numeration that these activities provide make mathematics seem to associate with real life even more so."

The significance of personal meaning was mentioned often in the geometry and measurement seminars, as these were topics with which many students had little informal or concrete experience. One student wrote: "Concrete materials and emphasis on geometry in our environment makes learning more meaningful." Another noted: "'Metric Me' is an excellent station as the children are not only working with math but are finding out things about themselves."

Taking into account that children come to every learning situation with rich personal experience, one student noted, "So many different activities, concrete materials, shapes help draw on children's past. This helps children learning new numbers--it draws them into number ideas." Helen used the same terms, saying: "There's so many experiences you could draw on, couldn't you?"

If learning is unique and requires a personally meaningful context, it also is necessary for the learner to have a personal goal. Following one lab activity, a student reflected on this, writing:

> As I worked through the exercises using the various materials I realized how easy it was just to follow the instructions without knowing why I'm doing it. (What to I hope to learn?) And applied to teaching--it's so easy to just tell the children to do this or that, leaving them confused because they don't know what they are supposed to be learning. -- is there 'a point' to what they are doing?

Helen spoke of a similar feeling regarding the non-education mathematics course she had taken. At the time, she was not aware what the objective was or how it could help her as a future teacher, and she still was unsure. In her words, the course did not "fit." Making clear to students what the purpose of a lesson is was important to Bob, especially during lectures. He remarked: "Teaching is communication and learning can be enhanced if the student knows what to expect."

Teacher Control

To ask who determines goals for learning implies the need for control, and may put the learner and the teacher in dichotomous positions. Consider two extreme conditions: the teacher sets all the goals for the student and monitors their acquisition; or the learner sets and monitors all the goals without any counsel from a teacher. In the former case, learning would not take place without a teacher, and in the latter case, a teacher would seem not to be required at all. When a teacher is seen as a goal-setter for a learner, then the learning is basically one-way, from teacher to student. Of course interaction is required, but it is for the purpose of directing the student. On the other hand, if no teacher is present, then there is no student-teacher interaction, and the learning is completely independent and personal.

Extreme situations are easy to reject as being unrealistic, and for that reason, they often are not taken seriously. My purpose is to illustrate this bi-polarity and consider the teacher's role in that context. First of all, the dichotomy needs to be dissolved. At any age and in any circumstance, the one cast as a teacher can learn from the one cast as a learner. The learner must be actively involved in goal setting, yet the teacher, being sensitive to the needs of the learner, has the responsibility to help the learner learn how to set goals rather than to set goals unilaterally. In this sense, the teacher's role is crucial, yet always tentative and unpredictable.

In this study, the issue of control was pervasive, and revealed many inconsistencies. As learners, the students wanted both to be controlled and to control; and as future teachers, they wanted to control and to learn to promote independence. Control was important to Bob and he remarked on it often. When the students talked during lectures and closed their books near the end of class, he said the teacher was "not in control" and that the students were "dictating." Thinking about himself as a teacher, he wrote: "Do I want my students to have control of my lesson?--Not bloody likely!" Control in a similar context was mentioned by Jennifer when she recalled her junior high days. She attributed her positive memories, in part, to her feeling that "the teachers had a lot of control."

While Bob believed that a teacher or lecturer should be in control of the class, he was anxious about the possibility of others having control over his learning. When group work for assignments was suggested, initially he reacted: "Never!! Responsible for my own success or failure." Later in the term, as he anticipated his student teaching assignment, he said, "I'm very concerned. From what I understand, a hostile or unsympathetic cooperating teacher can really hurt your career." Dianne, too, was apprehensive about her upcoming practicum. She was unsure about the extent she would be able to use her own ideas in the classroom, and felt that her experience could be hampered if she had a partner who held a philosophical outlook different from her own.

The two biggest sources of dissatisfaction in the course were the peer evaluation and the overall grading system. Many students viewed the peer evaluation as an opportunity for them to control their colleagues' grades. Even those who trusted their peers to be fair, doubted their competence due to their inexperience. They did wish for control, but preferred that of an authority. Jennifer, Dianne, and Lorna all spoke to this issue. Jennifer explained: "We're used to having kind of an arbitrator you know, a prof or a marker, or somebody to appeal to."

This problem was related to how students perceived the grading system. While relative standing with respect to point count was one determiner of grades, there were no preset equivalences of points to grades; and there was no requisite number or proportion of failures. In fact, it was the misinterpretation that a certain percentage would fail that caused near panic in some cases. Hearsay further misconstrued this as a technique to eliminate students from the program. Lorna reacted: "I'd rather see them put a quota on the people coming into education." When the issue of evaluation was raised in class, feelings were expressed among the students. Jennifer felt that those who were most vocal may have been attempting to exert control themselves. She said that they may have thought, "I've got a five. Maybe if we get angry enough [we can] turn it [into] a six." She speculated: "I think that was part of what motivated people to speak out."

Many students objected to the spirit of competition which was influenced by the relative ranking procedure. If ranking was to be used, Lorna suggested that point count equivalences for grades be established and given to the students at the beginning of the course. This procedure, she felt, would eliminate competition and also help students know where they stood from the start. As with the peer evaluation, control was expected and desirable when it was perceived as "fair."

Learner Control

Throughout the seminar sessions, students took part in hands-on child-centred activities which contrasted the teacher-tell lessons most of them had experienced in school. This led some to reconsider the familiar model of teacher-controlled learning. One student wrote: "There are many different strategies children use when subtracting and adding. There is not one standard way that should be taught as the golden rule." Teachers who want their students to be creative in mathematics must be willing to redirect their influence. Assumption of inherent teacher power was evident in the following statements: "I should allow students to deviate from the traditional method (right-left) learning of operations in math"; and "I should not make children conform to one (my) method." Another student pointed out the consequences of insistence on conformity, proposing: "It would be better to encourage the children to think critically and use different (varieties) of strategies than to have them all 'programmed' to do the same thing."

The notion that children can learn independently was considered somewhat tentatively by some students. For example, one student conceded: "Children can learn some things on their own." Respect for learner choice may be easier to accept for optional enrichment topics, and this is reflected in the comment: "The extension unit is very good for children to do something they want to do. I think the teacher should consult the students before designing this very subjective unit." Another student pointed out the importance of self-esteem, which is promoted when learners are allowed to pursue goals independently: "The children will probably experience much more of a feeling of competency and freedom and self-worth to know they can use their own method of problem solving which is not wrong just because it is different." Dianne felt that independence was of most significance, writing: I think the importance lies in teaching children to solve problems--to learn--to find out out through various ways, mathematical concepts without being told what those concepts are."

Appreciating the need to promote individuality, many students reflected on the teacher's responsibility in the classroom. Generally, one student remarked: "As a teacher I will have to find ways to foster individuality and growth." The need for teacher guidance was emphasized in the statement: "Have specific goals and guided discovery, do not let them work without any direction." Children's natural predilection for learning was affirmed by a student who wrote: "I need to let children become creative in problem solving by giving them the opportunity."

Motivation

Learning requires motivation. Ideally, this is self-generated, but the teacher's role in sparking interest is not trivial. Many of the students came to this course with the belief that mathematics was inherently dull and unmotivating. Helen was both surprised and enthusiastic about the concrete lab experiences. She wrote: "Fascinating to find that geometry can be so interesting." The students often commented that the activity approach to learning was fun, even for them. Most had been exposed to minimal use of materials in teaching mathematics. Finding that the materials themselves were stimulating, Helen concluded: "I would use these teaching devices as a motivator and lead into concepts that I wanted the children to learn." Another student indicated a desirable outcome of stimulated learning: "People were having fun, they were thinking about what they were doing working together--ideas stuck with me longer because it was so interesting." Positive experiences keep motivation alive. Bob spoke of the "joy of learning". He said, "True learning makes the hair stand up on the back of your neck."

Learning to Teach

Related to motivation is the notion of being ready or predisposed to learn. While the lab activities provided models for motivating children, students, in order to learn from these experiences, had to be prepared to learn. Dianne and others spoke of this as problematic. Some students, they regretted, came to the labs only to put in time, and in so doing, they affected the learning of their classmates.

Identifying and choosing appropriate personal goals was also addressed by Dianne and Helen. Dianne regretted that the program had allowed her to take all her non-education options in her first year. At that time she had not seen the value in taking a mathematics course, and chose philosophy because it satisfied the non-education mathematics requirement, and she thought she would find it easier. She said: "At that point in anyone's educational career they don't really know what's going to benefit them as a teacher. I certainly didn't!" Helen did take a mathematics course, but could not appreciate its significance for teaching children. She explained: "Maybe if I were to take the CI first and then take the [element] course . . . then maybe it would have made sense."

Lorna also experienced confusion, and felt somewhat let down. She wrote:

> It seems there are so many things to consider and so little time to really expand on these further. This is one thing I find disappointing about university but I do realize we are presented with guidelines and are encouraged to do more of the searching on our own.

During the course, Jennifer pondered the dilemma of learning for herself or learning to write tests. After the first test, she said she was not frustrated by the fact that much of what she had learned was not tested. When studying for the second test, she was somewhat nervous because she found the material to be "enriching but not full of information which lends itself to testing." Both Jennifer and Lorna commented that their marks did not reflect what they knew or how well they had prepared for tests. Jennifer said that many students had similar feelings.

The textbook was very popular with the students both because it helped them feel prepared to teach and it was easy to study (when preparing for tests). Representative of how others felt, Jennifer noted: "Main points are stated, emphasized, then stated again at the end." Similarly, Dianne remarked: "The test is . . . conducive to study." Bob concentrated on application of knowledge rather than memorizing facts. During lectures, he looked for main points that may appear on tests, making notations in the margin of his notes.

The need to set and pursue personally meaningful goals was recognized by most students. They constantly monitored their learning, often distinguishing that which they felt was most meaningful from that which they felt they were expected to learn.

Learning to Learn

Learning about teaching cannot be separated from learning about learning; and during the course the students acquired many insights into their own goals and processes of learning. For example, Bob wrote: "I personally find that [lecturing] is an effective was for me to be taught facts. But I don't know if I'm being educated when I learn facts."

By far, the most self-understanding occurred in the seminar sessions. Most students viewed mathematics as a very abstract discipline, and had expected to be exposed to the symbolic pencil and paper exercises by which they had learned in school. Following the first seminar which used concrete materials, one student admitted being skeptical: "I couldn't see the use of the objects or activities before the lab." Many students found that there were concepts which they had never really understood before, or which were clarified through the lab activities. Helen noted: "It was much easier to see relationships using the manipulative objects." Another student admitted: "Perhaps in math I still operate at a concrete pre-symbolic level. Calculus was too symbolic for me. We should have had activity sets to use."

Learning is seldom accomplished without some frustration, as one student wisely discovered: "Patience is needed in order to make yourself understand." Another expressed delight even though confusion was experienced: "I never had an opportunity to discover geometry before. I found it very motivating; even though, occasionally I got frustrated." Dianne, too, suffered some frustration with geometry, but later accounted for this: "I just couldn't put any of the [tangram] pieces together. . . . but I think it's just because I was trying to get it right away." She further reflected: "If you're frustrated to an extent I suppose that makes you want to figure it out. but . . . if you get really upset . . . it's not a learning experience."

Frustration may result from forgetting what has been learned. Bob mentioned this following the problem solving lab, where he had been intrigued by a solution presented. He wrote: "[It was] exciting to follow his logic and method. Now I'm frustrated because I can't remember the steps." Bob spent much extra time trying to improve his own problem solving ability. He did feel successful, but was sometimes impatient with himself. On one occasion he admitted: "Maybe I'm looking for a math 'pill' which will put everything into focus. Not too realistic, is it?"

Frustration can result in feelings of inadequacy which are not easily dismissed. One student was discouraged:

> I felt very inadequate about my abilities in the lab. Perhaps I shall have to review personally the entire mathematics curriculum in order to feel more secure and confident. Either I was not taught properly or else I have forgotten the majority of the material.

Dianne said that she enjoyed mathematics better in school when she did well, and she felt early success was especially important, saying: "It seems like if the child does not do well at the beginning then they'll always have that image of themselves." Helen also recalled elementary school days: "I was pushed and I was pushed to frustration and I don't think that's necessary."

The activities which led to personal insights about learning were exciting, surprising, satisfying, and frustrating. Such experiences were valuable, however, as they strengthened the students' understandings of mathematics and the learning processes.

Understanding How Children Learn

Learning about their own learning, by its very focus, led the students to see the importance of understanding how children learn. One student noted: "My ways of thinking and a child's way of thinking are very different. I must be able to break down my own thought patterns to relate to their level of thinking." Lorna found that she had simply not thought about some things from a child's point of view. She wrote:

> I had not ever really considered [our number system's] simplicity and relationship to the monetary and metric system, by this I mean

> the base 10 aspect. I guess this is just taken for granted in daily use but such considerations are very important when teaching.

Once again, the lab activity sessions helped the students to understand mathematics from a child's point of view. One student discovered: "I have to manipulate the materials myself in order to fully comprehend the concept. It is not enough to be a spectator in these activities. . . . This really came home to me by 'playing' the role of a learner." In one activity the students examined and discussed samples of children's computational procedures. Seeing the patterns and rules which children had devised was an eye-opener for many. Jennifer wrote: "The 'sense' that children can create out of the seemingly 'arbitrary' algorithms is fascinating." Similarly, another student observed: "Children's errors do seem logical--they make generalizations of rules." These invented processes gave insight into how children learn. One student noted: "Errors are more important in understanding how a child is processing info than correct answers." Implications for teaching are evident in the statement: "Students in these exercises did what was natural to them. By using this natural ability, computation can be understood and applied in a shorter time."

Understanding how children learn is vital to the teaching of elementary mathematics. By working through activities designed for children, the students discovered things they had taken for granted, and emphasized the need to respect children's thinking.

Writing and Learning

The purpose of the study was to gain some understanding of the experience of participating in ED CI 216 from the students' point of view. The experience was considered to be continuous for the duration of the course, not just when attending the scheduled lectures and seminars. Journals were kept by the five main participants to help them keep track of all course-related activities and to reflect on, or react to, any aspect of interest or concern. The writing was intended to be of personal benefit to the students. By making an intentional effort to write, it was hoped that their learning would be enriched and they might gain a deeper insight into their own thinking and feelings.

The journal writing also served as a medium for a personal dialogue between me and each student. In each entry that I made, I responded to what the student had written and often posed questions, sometimes to provoke reflection, and sometimes to have them clarify thoughts in previous entries. All five participants felt that the writing was a positive experience.

Bob was keen on keeping a journal from the start. He saw it as "a new method of study" and "of self-analysis." Class notes were part of his journal, and he made running remarks in the margin during lectures. He said that these comments helped him to remember the material, and that making entries forced him to pay attention so he could respond. Periodically, he wrote longer reflections on various aspects of the course and sometimes made inquiries.

Dianne often asked questions and used the journal writing to work out feelings she had about the course. Lorna felt that the journal helped her to reflect and pay more attention to what was done in class. She said: "It makes you think," and added, "you tend to even look over your notes more, just to think about what might have interested you the most or what seemed to be, you know, a problem." She found the feedback "encouraging" and thought that there would have been less benefit to her if it had not been received.

Jennifer "enjoyed" keeping her journal. She said, "It got me doing my math more often." She would check things in her textbook when making entries; and the writing prompted her to think about math on weekends and days when there were no classes. She found the experience valuable: "I think it made a difference in my performance in class and I didn't miss any lectures because . . . something could have been pertinent."

The most exciting result of the journals was the insights gleaned by Jennifer and Helen. Jennifer expressed surprise: "As I wrote I was coming up with ideas just as I wrote that I wouldn't have [come up with] if I hadn't [been writing]." Helen had similar experiences and spoke enthusiastically:

> There's some revelations I came to . . . there were things that were bothering me and not until I started writing did they come out. I found that very interesting! Things that had been bothering me and I couldn't figure out why I was so bottled up--as I started to write it seemed that what I was writing had an awful lot to do with what I was feeling.

She found the experience "beneficial to no end!" explaining: "I found out things about myself using the journal that I didn't know." She also appreciated the dialogue style because "it's almost like there's someone listening." As to using journals outside of the study, she said: "It would help in life in general . . . because some of the emotions you have just seem to come out when you write better than they do to verbalize them." These are examples of how the pre-reflective knowing or sensing is the starting point in personal learning. A similar illustration was given by Prescott (cited in Valle & King, 1978).

The journals were definitely beneficial to me as a researcher, in understanding how the students interpreted their experience. Because journal writing, both in style and content, is so personal, it is difficult to assess individual gain. All participants did seem, however, to find the writing worthwhile, even during the short time of the study.

Learning and control were powerful and consistent themes in this study. Beliefs about control were often implicit, and even when identified were difficult to overcome. The students learned much about learning: that it takes time; it involves risk; it can occur collaboratively, yet be unique; it requires motivation and readiness; and, understanding one's own learning has implications for understanding how children learn. Control was considered from both the learner's and the teacher's point of view.

Researcher Reflections

The phenomenological approach to perception was central to this study. Beginning with individual students' perceptions of their experience, patterns emerged, revealing shared interpretations, yet never obscuring the unique. The life-worlds of Bob, Dianne, Helen, Jennifer, and Lorna were featured, not because they epitomized the patterns, but to provide close-up views of individuals as their stories were interwoven throughout the themes.

The students' experiences and my experience as an instructor-researcher were co-constitutional. When developing the students' themes: Getting Through the Course, Feeling Prepared to Teach, and Looking for Models; I attempted to present their experience as they structured it, yet I was an integral part of that experience. This required the recognition and withholding of personal biases and expectations, influenced by my background experience as a student and as an instructor. My interpretation as an instructor-researcher, presented through the theme Learning and Control, was based on a holistic approach to learning. The students did not explicate this theme, rather it was my perception of their learning experience.

As an instructor-researcher, I attempted to understand how preservice teachers structured their experience during an elementary education mathematics curriculum and instruction course. Throughout the study, my own journal writing, the dialogue writing with the students, the interviews and discussions, the weekly lab summaries, and the general course evaluations, were all opportunities for me to examine my own role as an instructor. While my ultimate goal was to improve such experiences in the future, I did not expect to discover solutions to issues that the students identified as problematic; and considered any implications as suggestive rather than prescriptive.

The qualitative methodology was in keeping with the views of perception and learning which were basic to this investigation. Techniques used were similar to those employed by ethnographers, but the short time span and relatively small number of participants limited the depth and breadth of understanding to that of a case study. Also, my role of researcher as one of the course instructors was integral rather than that of an objective participant-observer. Uniqueness of experience was supported by the study, and the resulting description is intended as a sharing of my experience. The value to other instructors would be variable, depending on their sensitivity to my perception.

CHAPTER VI

IMPLICATIONS AND FURTHER RESEARCH

The purpose of the study was, for me as an instructor, to gain an understanding of how students interpreted their experience while participating in ED CI 216, an elementary mathematics curriculum and instruction course. The nature of the study was descriptive and a thematic approach was used to present the data. Three major themes: Getting Through the Course, Feeling Prepared to Teach Mathematics, and Looking for Models, addressed the experience from the students' point of view; and the combined themes of Learning and Control formed the basis for my interpretation of the experience as an instructor-researcher.

Implications

As a descriptive case study, understanding was the major goal; specific recommendations were not an expected result. The themes do offer, however, insights which have significance for both teacher education and mathematics teacher education. Getting Through the Course, which focused on the participants as students, may have touched concerns which could arise in any course. Feeling Prepared to Teach Mathematics might have counterparts in other subject areas, though there likely would be distinct differences in the component issues. The theme which probably speaks most to teacher education generally is Looking for Models. While there are no clear-cut practical applications of what was learned, awareness of the themes and what gave rise to them can enhance sensitivity for recognizing them in other situations where specific circumstances may vary.

A key element of the study was my role as an instructor-researcher. While ethnographic techniques were used, the result certainly is not an ethnography in the usual sense. As both instructor and researcher, I was not a complete outsider to the culture of preservice teachers who were enrolled in the course; student-instructor interaction was a vital part of their experience. Nor was I merely observing the students, and when I was, I was also observing myself because what I saw in their experience was influenced by me. An ethnographer avoids influencing a culture and, ideally, presents an unbiased description, usually to others outside that culture. In this case, however, the intended audience is other members within the culture of preservice instructors, and this allows for implicit as well as explicit communication.

In this study, my role as an instructor-researcher was a special one. Though I presented lectures and supervised lab activities, I was not directly involved in evaluation of assignments or exams. Developing a relationship of trust with the students was of prime importance, especially with the five main participants. Trust is not automatic in any relationship, but requires time and willingness to risk personal views. As the relationships between the five main participants and me developed, the uniqueness of each person was increasingly revealed; and the relationships were sustained by mutual respect for the beliefs and feelings which were shared.

An instructor of a class of 200 students could never, over the course of a term, develop such relationships with each person. In ED CI 216, as in every course, there were some students who chose to maintain a high profile from the beginning, and who sought closer relationships with their instructors. The majority of the students tended to have a fluctuating relationship; that is, sought out their instructors when they had immediate concerns, but otherwise kept their distance. At the other extreme, were those students who seemed to prefer the anonymity which the large class afforded them, and rarely, if ever, approached their instructors. As an instructor-researcher, I needed to consider all students' views in order to construct a comprehensive picture. While the amount of data gathered from the students varied, they all completed lab summaries and were given the opportunity to submit anonymous course evaluations.

Though the themes indicated patterns of experience among the students, variations and inconsistencies within the patterns repeatedly affirmed the uniqueness of each individual's perception. For example, Dianne expressed a need for more emphasis on mathematical content, while Helen felt that teaching methodology should have priority. Lorna was upset by the evaluation procedure, Bob was ambivalent, and Jennifer did not perceive it as problematic. This indicated, from an instructor's point of view, the difficulty of satisfactorily addressing the needs of each student. When planning a course, awareness of the themes can provide direction, yet an instructor must remain responsive to individual needs. Considering the importance of the modeling role which was indicated by this study, showing concern for the students as individuals must be done with sincerity. As adults, they may see themselves as independent and self-responsible, yet as students, they often feel some dependence and want instructors to respect their vulnerability.

In order to know the personal needs and viewpoints, I had to listen and be prepared to hear things which were disturbing to me, and I had to be open to criticism. For instance, I had a tendency to speak very quickly when lecturing. Bob monitored this, and often commented that I went too fast or that my pace was good. This not only led me to slow down, but to reflect on why I felt a need to do so much in 50 minutes, and to consciously regulate my own pace.

My role then, as an instructor-researcher had not been predetermined, but rather it emerged throughout the term. Most students were cooperative, and as I became more sensitive to their goals and needs, I gained confidence in myself as a research instrument. In fact, the students themselves helped to define my role through their own needs as they reflected on their experiences.

Specific suggestions would be very vulnerable to change with respect to time and place, whereas themes, while not immutable, are more general and enduring. For example, particular concerns about getting through a course would vary, and students would have different goals and expectations concerning feeling prepared to teach. Also the intensity of these themes, which fluctuated throughout the course, may follow distinct patterns in other cases.

In this course, students found the work load especially heavy due to the short term. Lightening the load or lengthening the term would not have eliminated the problem automatically. Concerns about pressure are always relative, depending on the personal circumstances of each student. However, sensitivity to what might increase pressures in any particular course, may indicate possible changes or at least provide understanding.

The need for interaction seemed crucial to many students. While there are individual differences, perhaps those people who choose to become teachers naturally are more interactive, and development of interpersonal skills is highly valued for teachers. Smaller classes may be necessary, but reduction of numbers alone cannot solve the problem. To fulfill these needs, an instructor also may have to rethink the nature and structure of classes; but this would require individual interpretation, depending on outside restrictions and available resources.

Evaluation, which was another major concern in this course, is a perennial issue. Both the function and form of evaluative procedures require consideration; and these are affected by many factors, including the size of the class. In this course, competitiveness was increased because of relative grading as well as the precarious state of the job market. The need for what the students perceived as fair was most dominant.

Because students began the course with diverse backgrounds, goals, and objectives, accommodating individual differences was difficult. Understanding of the nature of these differences and explicitly addressing them can help to reach more students, and enable them to set personal goals. Those who enter with a fear of mathematics usually have to change their conception of what mathematics is. The current focus in mathematics education is on the promotion of independent, creative mathematical thinkers who can apply mathematics in personally meaningful ways in their daily lives, both formally and informally. Students who are fearful usually see mathematics as a complicated system, entirely abstract, rigid, and disconnected from the real world; and deep feelings and attitudes are difficult to overcome. Time is a factor, but participation in collaborative activities which allow low pressure risk-taking, can help these individuals to develop an appreciation of mathematics.

Acquiring methodology and practical ideas for teaching mathematics was a common goal. This is an age-old problem in teacher education, and was heightened in this course due to the impending practicum. The notion of readiness to learn was apparent here. Many students were intrigued with new ideas, but others who could see no direct classroom application, dismissed them. This implies that students cannot be made to, nor should they be expected to, accept uncritically, views different from their own. Encouraging students to identify and question their own assumptions is not easy because many of them are implicit, but the opportunity can be provided.

The role of the instructor as a model for teaching is fundamental: The manner in which the issues of workload and time pressure, interaction, evaluation, mathematics anxiety, and theory versus practical application, are dealt with presents a model, intended or not. Maintaining consistency of principle and practice requires self-evaluation. For example, lecturing to students about using an individualized activity approach with children may be perceived as contradictory, or attempts at personal interaction in a group of 200 students might be viewed as insincere. Awareness of the significance of being a role model can lead to personal examination and change.

The journals were successful, but the dialogue approach seemed important. In a large class, this could be unmanageable. Journal writing does have many forms, however, and a suitable one may possibly be developed. For instance, students might select partners for written dialogues, and periodically share insights and feelings with the instructor and class. This is one area that need not, nor should not, be restricted to any subject area, but has significance for teacher education in general.

Being descriptive in nature, the purpose of this study was to portray understanding of the preservice teachers' experience. The implications which resulted were not prescriptive in nature, but the themes which arose are indicative of underlying issues of significance to both teacher education and mathematics teacher education.

Further Research

This study was limited to the preservice experience of an elementary mathematics curriculum and instruction course. Natural extensions are suggested by extending these boundaries.

During the practicum which immediately followed ED CI 216, Bob was assigned to a grade four class. He described the setting as traditional, with the desks set in rows. Mathematics was taught by teacher-directed lessons with the whole class. When I enquired about use of learning materials, he replied, "Only flash cards." As to concrete learning aids (Bob had taught subtraction with regrouping), he explained that the teacher felt that they were unnecessary at that level. The seminars in the course had dealt completely with activity and group learning, with materials appropriate for all elementary grades; what Bob experienced in the following weeks was contrary to this approach.

Case studies of student teaching experiences with a focus on mathematics teaching could provide insight into what happens when the course is over. Such research might yield some understanding of how student teachers cope with situations which are inconsistent with their personal philosophies of education, which are in a developmental stage. This is a very sensitive area, but one which could have significant implications for mathematics teacher education.

Studies similar to this one could be conducted in other curriculum and instruction areas. If similar themes were discovered, they would not only confirm the results of this study, but would indicate more significance for teacher education in general.

This study involved students in a first-level mathematics curriculum and instruction course; but similar techniques could be employed in a senior-level course, and the findings compared. The issues of personal learning and the function of control would be of particular importance.

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APPENDIX 1

UNIVERSITY OF ALBERTA

Department of Elementary Education

ED CI 216 COURSE OUTLINE Fall, 1986

Curriculum & Instruction in Elementary School Mathematics

Purposes:

1. To develop a perspective on the teaching/learning of mathematics.
2. To consider a variety of processes and materials for teaching/learning mathematical concepts at the elementary school level.

Text: Kennedy, L. M. Guiding Children's Learning of Mathematics. Wadsworth, 1984.

Evaluation:

Laboratory work	20%
Laboratory assignment	10%
Quiz #1	20%
Quiz #2	20%
Final Exam	30%

Schedule:

Sept 08 Introduction
09 Teaching Mathematics
lab
15 Problem Solving
16 Problem Solving
lab
22 Early Number Ideas
23 Base and Place Value
lab
29 Quiz #1
30 Operations
lab
Oct 06 Computation
07 Computation
lab

Oct 13 Thanksgiving
14 Fractions
lab
20 Decimals
21 Calculator
lab
27 Quiz #2
28 Measurement/Graphing
lab
Nov 03 Geometry
04 Geometry
lab
10 FINAL EXAM

APPENDIX 2

UNIVERSITY OF ALBERTA

Department of Elementary Education

ED CI 215/315

Mathematics Component Outline

Our fundamental goal in the mathematics component is to help you as students and as teachers to become aware of the richness, beauty, and power of mathematics, both as a field of human creation and as it exists in the world of mathematics, and to set you upon a path of making the world of mathematics come alive in your own world and in the lives of children. More specifically, with your cooperation, we will be working toward the following five sets of goals.

A. Understanding Children

become aware of the developing mathematical world of children, paying particular attention to the rich and varied ways children use to make sense of their surroundings;

appreciate the naturalness of the child's own processes of interacting with the spatial, structural, quantitative, and transformational nature of the world;

B. Understanding Mathematics

become familiar with some of the basic processes of mathematics which are used time and again to build mathematics concepts;

appreciate mathematics as a search for and the construction of patterns;

recognize the general nature of the problem solving process in mathematics, and to use the Polya paradigm to solve mathematical problems;

C. Understanding Curriculum and Instruction

acquire a broad conception of the mathematics curriculum and become familiar with the way the provincial program of studies sets out the mathematics program for elementary schools;

acquire a working knowledge of methods of teaching mathematics, methods which build upon and complement the naturally developing thought of the child for each of the following topics;

Problem solving
Pre-number
Number
Numeration
Operations
Computation
Geometry
Measurement
Fractions
Calculators
Computers

D. Making Connections

recognize that mathematics has been called "The Queen of the Sciences," for good reason, but that science is only one of the areas of human endeavor which enlightens and is enlightened by mathematics;

appreciate the integrative function that mathematics can play in the perception and development of patterns in our view of the world, both natural and man-made;

D. Growing Professionally

begin to realize and to appreciate that mathematics, like philosophy, is a search for fundamental ideas of the universe, and that the teacher's participation in the construction of the child's growing understanding of the universe will be of value only if the teacher is engaging in that same process both personally and professionally.

Text

Kennedy, L. M. Guiding Children's Learning of Mathematics (4th Edition), Belmont, California: Wadsworth, 1984.

Elementary Mathematics Curriculum Guide. Alberta Education, 1982. (optional)

Assignments

Assignments and grading are described in detail in separate handouts.

APPENDIX 3

UNIVERSITY OF ALBERTA

Department of Elementary Education

ED CI 315 B1

Mathematics Component

January, 1986

M. Hauk
Office: 234
Phone: 432-4124
Hours:

Goals and References:

The goals and general references for all mathematics components are included in a separate handout.

Purposes:

1. To provide an overview of the mathematical concepts contained in current elementary mathematics programs.
2. To introduce a variety of procedures for teaching these concepts to elementary school children.
3. To promote a positive and professional attitude toward the teaching of elementary school mathematics.

Text:

Kennedy, L. M. Guiding Children's Learning of Mathematics. (4th Edition) Belmont, California: Wadsworth, 1984.

Evaluation:

Midterm Exam	- 35 points	- February 12
Assignment	- 35 points	- March 10
Final Exam	- 30 points	- TBA
Total	100 points	

MH315MA
Disk: 7a

APPENDIX 4

INFORMED CONSENT FORM

The research project to be conducted by doctoral candidate Marie Hauk has been explained to me.

I understand that my participation is completely voluntary. Further, I understand that my participation involves engaging in formal or informal interviews and keeping a journal of my experience throughout the mathematics curriculum and instruction course.

Additionally, I understand that all information provided by me will be kept confidential and my identity will not be revealed. I understand that I am free to withdraw my consent and discontinue participation in the study at any time.

It is my understanding that the final report of this study will be the candidate's dissertation. I further understand that all questions I have about the study will be answered by the candidate.

On the basis of the above statements, I agree to participate in this project.

Participant's signature	Investigator's signature Marie Hauk 315 Dechene Road Edmonton, Alberta 487-8841

APPENDIX 5

Name: ______________________

I.D. #: ____________________

Section #: _________________

Date: ______________________

The Teaching of Mathematics in Elementary School

ED CI 216 LAB SUMMARY

1. Topic: ____

2. Significant Observations: ____________________________

____

____

____

____

3. Major insights or implications for myself as a learner and teacher of Mathematics in Elementary School:

____

____

____

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____

____

File: DSLAB
Disk: 7b

APPENDIX 6

The proposed use of lab summary sheets in the research project being conducted by doctoral candidate Marie Hauk has been explained to me.

I understand that my permission for statements to be quoted is completely voluntary, and that my identity will not be revealed.

I further understand that the final report of this study will be the candidate's dissertation.

APPENDIX 7

JOURNAL EXCERPTS

Bob: Monday, September 22

(before class) Bad headache. . . . The class is far too big. Is lecture format an effective way to teach? What will my teaching method be like--to lecture or to let kids discover it themselves--or a mixture of both? Class to start now . . .

(during class) Assignment: Group work suggested--Never!! Responsible for my own success or failure.

Marie: Thursday, September 25

The class is big--that's true. I, myself do not feel comfortable lecturing to 200 people. You ask if lecturing is an effective way to teach. How do you find it as a learner? Do you feel the same in a class of 30 students as you do in a class of 200? As a teacher, I feel distant in that large room--the communication is almost exclusively one-way--and very impersonal. When you think about teaching--think about learning--and vice versa. You said "never" to group work because you wanted to be responsible for your own success. Good--you do want to be in control of your learning--but does that mean that learning has to be a solo affair? What really bothers you about group work? Is trust involved?

Bob: Friday, September 26

Your questions neatly pinpointed several issues which I have been grappling with ever since I came back to the University. One--the issue of trust--is intensely personal and is not one I wish to examine in any depth--mainly because I don't know where it will take me. Self-examination can be very disturbing and a little frightening. . . . Learning by being lectured to--I personally find it an effective way for me to be taught facts. But I don't know if I'm being educated when I learn facts.

Marie: Thursday, October 2

You are right about self-examination--it can be scary--but don't avoid it.

Jennifer: Sunday, October 12

This has been a great week for math. I sat down to brainstorm ideas on my math group project and I developed a card game. . . . I am so excited about this game and how easily it came together.

Wednesday, October 15

I felt somewhat uncomfortable in the presence of all my classmates in a marking/evaluating capacity. Perhaps some coaching in evaluation/awareness considerations? We thought it would be neat if we could mark the other class's [a different seminar section] projects.

Marie: Monday, October 20

I can see that you and your group put considerable efforts into the assignment. I hope you feel that your efforts were worthwhile. As you mentioned, evaluation is very difficult--probably the hardest thing you will do as a teacher. . . . How are you feeling about the practicum experience--do you know yet where you will be teaching?

Jennifer: Saturday, October 25

I am spending the weekend in Calgary and the weather is glorious. That makes it tougher to study for my exam on Monday. . . . In terms of "facts" there are fewer things to remember, and that makes me nervous. Oh ho! What am I learning? It is material which is enriching but not full of information which lends itself to testing.

Monday, October 27

Well, I wrote the exam today and I think I did okay. . . . I found out where my placement is. . . . I'm feeling very excited about our practicums. The term is going by so quickly because it is broken up.

Marie: Tuesday, October 28

Hope you took some time to enjoy your break last weekend--as well as studying. That was probably a good time to reflect on learning and testing. . . . You are also very positive about your practicum placement--good!

APPENDIX 8

ED CI 216

Course Evaluation

This is an "open" evaluation in which you may focus on any or all of the course components, such as the lectures, seminars, exams, assignment and textbook. You may reflect on the objectives, organization, use of time, content, materials, workload, evaluation or any other aspect which you feel is significant.